CHEMISTRY

Faderal Board Islamabad

10TH CLASS

Presented by:

Urdu Books Whatsapp Group

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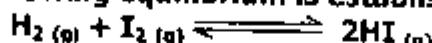
REVIEW QUESTIONS

1. Encircle the correct answer.

(i) Which is true about the equilibrium state?
- A. The forward reaction stops.
- B. The reverse reaction stops.
- C. Both forward and reverse reactions stop.
- D. Both forward and reverse reactions continue at the same rate.

(ii) When a mixture of H_2 and I_2 is sealed in a flask and temperature is kept at 25°C, following equilibrium is established.

$$H_{2\,(g)} + I_{2\,(g)} \rightleftharpoons 2HI_{(g)}$$

Which substance or substances will be present in the equilibrium mixture?

A. H_2 and I_2 B. HI only C. H_2 only D. H_2, I_2 and HI

(iii) What are the units for

$N_{2\,(g)} + O_{2\,(g)} \rightleftharpoons 2NO_{2\,(g)}$

A. $mol.dm^{-3}$ B. $mol^{2}.dm^{-6}$ C. $dm^{3}.mol^{-1}$ D. No units

(iv) Which of the following reaction will not have any units for K_c?
- A. $H_{2\,(g)} + CO_{2\,(g)} \rightleftharpoons H_2O_{(g)} + CO_{(g)}$
- B. $N_{2(g)} + O_2 \rightleftharpoons 2NO_{(g)}$
- C. $2A_{(g)} + B_{(g)} \rightleftharpoons 3AC_{(g)}$
- D. All of these

(v) Concentration of reactants and products at equilibrium remains unchanged if
- A. concentration of any reactant or product is not changed.
- B. temperature of the reaction is not changed
- C pressure or volume of the system is not changed
- D. all of the above are observed

(vi) Which of the following does not happen, when a system is at equilibrium state?
- A. Forward and reverse reactions stop.
- B. Forward and reverse rates become equal.
- C. Concentration of reactants and products stop changing.
- D. Reaction continues to occur in both the directions.

(vii) For which reaction, K_c has units of $mol.dm^{-3}$.
- A. $2NO_{2\,(g)} \rightleftharpoons N_2O_{4(g)}$
- B. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3\,(g)}$
- C. $PCl_{5\,(g)} \rightleftharpoons PCl_{3(g)} + Cl_{5\,(g)}$
- D. $2HCl_{(g)} \rightleftharpoons I_{2(g)} + Cl_{2(g)}$

(viii) In an irreversible reaction equilibrium is
- A. established quickly
- B. established slowly
- C. never established
- D. established when reaction stops.

(ix) Active mass means

A. total mass of reactants
B. total mass of products
C. total mass of reactants and products
D. mass of substance in moles per dm^3 in a dilute solution

(x) For a reversible reaction

$K_c = \frac{[C]^2}{[A][B]}$

Which substance is product of the reaction?

A. A B. B C. Both A and B D. C

Answers

i. D	ii. D	iii. D	iv. D	v. D
vi. A	vii. C	viii. C	ix. D	x. D

ختم نبوت ﷺ زندہ باد

عظمت صحابہ زندہ باد

السلام علیکم ورحمۃ اللہ وبرکاتہ:

معزز ممبران: آپ کا وٹس ایپ گروپ ایڈ من "**اردو بکس**" آپ سے مخاطب ہے۔

آپ تمام ممبران سے گزارش ہے کہ:

- ❖ گروپ میں صرف PDF کتب پوسٹ کی جاتی ہیں لہذا کتب کے متعلق اپنے کمنٹس / ریویوز ضرور دیں۔ گروپ میں بغیر ایڈ من کی اجازت کے کسی بھی قسم کی (اسلامی وغیر اسلامی، اخلاقی، تحریری) پوسٹ کرنا سختی سے منع ہے۔
- ❖ گروپ میں معزز، پڑھے لکھے، سلجھے ہوئے ممبرز موجود ہیں اخلاقیات کی پابندی کریں اور گروپ رولز کو فالو کریں بصورت دیگر معزز ممبرز کی بہتری کی خاطر ریموو کر دیا جائے گا۔
- ❖ کوئی بھی ممبر کسی بھی ممبر کو انباکس میں میسیج، مس کال، کال نہیں کرے گا۔ رپورٹ پر فوری ریموو کر کے کاروائی عمل میں لائے جائے گی۔
- ❖ ہمارے کسی بھی گروپ میں سیاسی و فرقہ واریت کی بحث کی قطعاً کوئی گنجائش نہیں ہے۔
- ❖ اگر کسی کو بھی گروپ کے متعلق کسی قسم کی شکایت یا تجویز کی صورت میں ایڈ من سے رابطہ کیجئے۔
- ❖ سب سے اہم بات:

گروپ میں کسی بھی قادیانی، مرزائی، احمدی، گستاخِ رسول، گستاخِ امہات المؤمنین، گستاخِ صحابہ و خلفائے راشدین حضرت ابو بکر صدیق، حضرت عمر فاروق، حضرت عثمان غنی، حضرت علی المرتضیٰ، حضرت حسنین کریمین رضوان اللہ تعالیٰ اجمعین، گستاخ اہلبیت یا ایسے غیر مسلم جو اسلام اور پاکستان کے خلاف پراپیگنڈا میں مصروف ہیں یا ان کے روحانی و ذہنی سپورٹرز کے لئے کوئی گنجائش نہیں ہے لہذا ایسے اشخاص بالکل بھی گروپ جوائن کرنے کی زحمت نہ کریں۔ معلوم ہونے پر فوراً ریموو کر دیا جائے گا۔

- ❖ تمام کتب انٹرنیٹ سے تلاش / ڈاؤنلوڈ کر کے **فری آف کاسٹ** وٹس ایپ گروپ میں شیئر کی جاتی ہیں۔ جو کتاب نہیں ملتی اس کے لئے معذرت کر لی جاتی ہے۔ جس میں محنت بھی صَرف ہوتی ہے لیکن ہمیں آپ سے صرف دعاؤں کی درخواست ہے۔
- ❖ عمران سیریز کے شوقین کیلئے علیحدہ سے عمران سیریز گروپ موجود ہے۔
- ❖ **لیڈیز کے لئے الگ گروپ کی سہولت موجود ہے جس کے لئے ویریفکیشن ضروری ہے۔**
- ❖ اردو کتب / عمران سیریز یا سٹڈی گروپ میں ایڈ ہونے کے لئے ایڈ من سے وٹس ایپ پر بذریعہ میسیج رابطہ کریں اور جواب کا انتظار فرمائیں۔ برائے مہربانی اخلاقیات کا خیال رکھتے ہوئے موبائل پر کال یا ایم ایس کرنے کی کوشش ہر گز نہ کریں۔ ورنہ گروپس سے تو ریموو کیا ہی جائے گا بلاک بھی کیا جائے گا۔

نوٹ: ہمارے کسی گروپ کی کوئی فیس نہیں ہے۔ سب فی سبیل اللہ ہے

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اللہ تبارک تعالیٰ ہم سب کا حامی وناصر ہو

REVIEW QUESTIONS

1. Encircle the Correct answer

(i) Which of the following cannot be classified as Arrhenius acid?
A. HNO_3 B. H_2CO_3 C. CO_2 D. H_2SO_4

(ii) NH_3 cannot be classified as a base by
A. Lewis theory B. Bronsted -Lowry theory
C. Arrhenius theory D. All of these theories

(iii) Which of the following is a Lewis base?
A. BF_3 B. HCl C. $AlCl_3$ D. F^-

(iv) Choose Lewis acid
A. CN^- B. $\ddot{N}H_3$ C. $H_2\ddot{O}:$ D. H^+

(v) A drain cleaner solution contains 1.0×10^{-8} M, OH^- concentration. This Solution is
A. acidic B. basic C. neutral D. cannot be predicted

(vi) Milk of magnesia contains $Mg(OH)_2$. It is used as antacid. It neutralizes excess stomach acid. Which salt is formed in this reaction?
A. $MgSO_4$ B. $MgCO_3$ C. $MgCl_2$ D. MgO

(vii) Ammonia is a base, because it
A. Ionizes in water to give OH^- ions
B. Contains OH group
C. Can accept an election pair
D. Can accept proton

(viii) Consider the following reaction?
$H_2O + HCl \rightleftharpoons H_3O^+ + Cl^-$
Which species is an electron pair acceptor in this reaction?
A. H_2O B. HCl C. H_3O^+ D. none

(ix) In the following reaction which species is donating an electron pair?
$NH_3 + BF_3 \longrightarrow H_3N - BF_3$
A. H B. B C. N D. BF_3

(x) An aqueous solution of NaOH is used as a drain cleaner. If the concentration of OH^- ions in this solution is 1.0×10^{-5} M, the concentration of H^+ ions in it would be?
A. 1.0×10^{-5} M B. 1.0×10^{-7} M
C. 1.0×10^{-9} M D. 1.0×10^{-14} M

Answers

i. C	ii. C	iii. D	iv. D	v. A
vi. C	vii. D	viii. B	ix. C	x. C

REVIEW QUESTIONS

1. Encircle the correct answer.

(i) Condensed structural formula for butane is
A. $CH_3 - CH_2 - CH_3$
B. $CH_3CH_2CH_2CH_3$
C. $CH_3 - CH_2 - CH_2 - CH_2 - CH_3$
D. $CH_3 - CH_3$

(ii) $CH_3 - CH_2 - CH_3$ is the chemical formula for
A. Ethane B. Propane
C. Butane D. Pentane

(iii) Which compound is not a saturated hydrocarbon?
A. $CH_3 - CH_3$ B. CH_4
C. $CH_3 - CH = CH_2$ D. $CH_3 - CH_2 - CH_3$

(iv) Stem "But" stands for how many Carbon atoms.
A. 2 B. 3
C. 4 D. 5

(v) Pitch is produced by
A. Coal B. Coal tar
C. Coal gas D. Petroleum

(vi) The functional group $-\overset{O}{\overset{\|}{C}}-$ is found in
A. alcohols B. Ketones
C. Carboxylic acids D. esters

(vii) In which of the following Compounds, oxygen is attached to two alkyl carbon atoms?
A. alcohol B. phenol
C. ether D. ester

(viii) Which of the following is an alcohol?
A. $CH_3 - CH_2 - O - CH_2 - CH_3$
B. $CH_3 - CH_2 - COOH$
C. $C_6H_5 - OH$
D. $CH_3 - CH_2 - OH$

(ix) The functional group of amines is
A. $-OH$ B. $-COOH$
C. $-NH_2$ D. $-CHO$

(x) Formic acid contains functional group
A. $-OH$ B. $-CO-$
C. $-COOH$ D. $-CHO$

Answers

i. B	ii. B	iii. C	iv. C	v. D
vi. B	vii. C	viii. D	ix. C	x. C

REVIEW QUESTIONS

1. Encircle the correct answer

(i) Which molecule contains a carbon-carbon double bond?

A. Ethane B. Ethene
C. Ethyne D. Ethyl alcohol

(ii) Which product is obtained when chloromethane (or methyl chloride) is reduced?

A. Ethane B. Ethene
C. Methane D. Ethyne

(iii) Which reacts explosively with methane?

A. F_2 B. Cl_2
C. Br_2 D. I_2

(iv) By dehydration we mean, the removal of

A. Hydrogen B. Water
C. Halogen D. Hydrogen halide

(v) Ethene and ethyne can be differentiated by

A. Hydrogenation
B. Bromine water
C. Dilute alkaline aqueous solution of $KMnO_4$
D. Hydrohalogenation

(vi) Which is used for dehydrohalogenation?

A. Br_2 water B. Conc. H_2SO_4
C. Al_2O_3 D. Alcoholic KOH

(vii) Which substance reacts with $KMnO_4$ to produced oxalic acid?

A. Ethane B. Ethene
C. Ethyne D. Ethyl alcohol

(viii) The reduction of alkyl halides takes place in the presence of

A. Al_2O_3 at 350° C B. Conc. H_2SO_4 at 170° C
C. Zn + Dust D. Zn + HCl

(ix) Which process produces an alkane?

A. Combustion B. Hydration
C. Dehydration D. Hydrogenation

(x) Does not react with aqueous solution of bromine

A. C_2H_6 B. C_2H_4
C. C_2H_2 D. C_3H_6

Answers

i. B	ii. C	iii. A	iv. B	v. C
vi. D	vii. C	viii. D	ix. D	x. A

REVIEW QUESTIONS

1. Select the correct answer.

i) Which compound found in every living cell, serves as the information and control center?

A. amino acid B. protein
C. lipid D. DNA

ii) Plants convert glucose into

A. starch B. lipids
C. proteins D. amino acids

iii) Glucose is a

A. tetrose B. pentose
C. disaccharide D. hexose

iv) Which is not a dextrose sugar

A. glucose B. mannose
C. galactose D. fructose

v) Raffinose, $C_{18}H_{32}O_{16}$ on hydrolysis forms _______ simple sugars.

A. 1 B. 2
C. 3 D. 3 to 9

vi) Which is not a source of starch?

A. wheat B. rice
C. cotton D. potato

vii) Which is not a protein?

A. gelatin B. antibodies
C. enzymes D. cholesterol

viii) Soaps and detergents are made from

A. proteins B. carbohydrates
C. fats and oils D. all of these.

ix) Which is not present in DNA

A. deoxyribose sugar B. ribose sugar
C. phosphate unit D. nitrogen base

x) Raffinose $C_{18}H_{32}O_{16}$ is a

A. monosaccharide B. disaccharide
C. oligosaccharide D. polysaccharide

Answers

i. D	ii. A	iii. D	iv. D	v. C
vi. D	vii. D	viii. C	ix. B	x. C

Q.1. Select the correct answer.

i) Percentage of sodium chloride in sea water is

A. 0.02 B. 3.4
C. 97 D. 2

ii) The density of water is maximum at.

A. 0°C B 4°C
C. 100°C D. - 4°C

iii) Which salt does not cause the water to become hard.

A. calcium hydrogen carbonate
B. magnesium hydrogen carbonate
C. magnesium sulphate.
D. Sodium chloride.

(iv) Which salt causes temporary hardness in water.

A. magnesium sulphate
B. calcium sulphate
C. both calcium sulphate and magnesium sulphate
D. magnesium hydrogen carbonate

v) Heating calcium hydrogen carbonate produces

A. CO_2 B. H_2O
C. $CaCO_3$ D. all of these

vi) Which of the followings is not a water born disease?

A. hepatitis B. typhoid
C. dysentery D. anemia

vii) Which human activity results in contamination of water bodies?

A livestock waste B. pesticides
C. septic tanks D all of these

viii) Which is used to remove permanent hardness in water?

A. slaked lime B. washing soda
C. boiling water D. all of these

Answers

i. B	ii. B	iii. D	iv. D
v. D	vi. D	vii. D	viii. B

2. Give short answers

REVIEW QUESTIONS

1. Select the correct answer

i) The naturally occurring metallic compounds are called as
A. ore B. gangue
C. mineral D. rock

ii) The separation of minerals from gangue is called concentration. Which of the following methods is used for concentration?
A. smelting B. roasting
C. refining D. flotation

iii) Which of the following steps is not used in the extraction process of metals
A. roasting B. smelting
C. flotation D. bessemerization

iv) In electrolytic refining of copper, __________ is used as anode.
A. pure copper B. impure copper
C. copper sulphate D. electrolytic tank

v) Which of the followings in not a raw material for the manufacture of soda ash.
A. ammonia B. carbon monoxide
C. brine D. lime stone

vi) A mixture of Cu_2S and FeS called matte is produced in one of the metallurgical operations in the extraction of copper. The name of this operation is.
A. smelting B. roasting
C. bessemerization D. electro-refining

vii) Chemical formula of slaked lime is
A. $CaCO_3$ B. CaO
C. $Ca(OH)_2$ D. $CaCl_2$

viii) Calcination is the process in which sodium hydrogen carbonate is heated to get sodium carbonate. Which is not obtained in this process?
A. CO_2 B. CO
C. Na_2CO_3 D. H_2O

ix) Percentage of nitrogen in urea is
A. 35 B. 21.2
C. 80 D. 46.6

x) What happens when ammonium carbamate is distilled with steam?
A. ammonia is produced B. carbon dioxide is released.
C. urea is produced D. urea solution is produced

Answers

i. C	ii. D	iii. C	iv. B	v. B
vi. B	vii. C	viii. B	ix. D	x. D

GLOSSARY

Acid is a substance that can donate a proton to a base.
Alkenes The family of hydrocarbons which contain one carbon-carbon double bond
Alkyl group a group of atoms that contains one less hydrogen atom than its parent alkane.
Aqueous solutions are the mixtures in which substances are dissolved in water.
Base a substance that can accept a proton from an acid.
Carboxyl group the COOH functional group
Enhanced greenhouse effect an upset in the natural balance of the concentration of greenhouse gases in the atmosphere.
Ethylene -the industrial name for ethene.
Fatty Acids are carboxylic acids which contain three or more carbon atoms in their chain
Functional groups are groups of atoms in an organic molecule which give particular properties.
Hard Water water containing dissolved calcium and magnesium salts which produce scum with soap.
Hydrocarbons -compounds containing only carbon and hydrogen.
Indicators chemicals that change colour as pH of a solution changes.
Organic Compounds -compounds containing carbon except carbon dioxide, carbon monoxide and carbonates.
Saturated hydrocarbons every carbon atom present in the hydrocarbon attached to four atoms.
Side groups groups of atoms such as CH_3 group, which are attached to the main chain of carbon atoms in the molecule.
Structural formula shows the arrangements of atoms in a molecule.
Unsaturated hydrocarbons molecules containing only carbon and hydrogen in which at least two carbon atoms form double or a triple bond.
Fossil fuels fuels made from the remains of decayed animal and plant matter compressed over millions of years.
Fraction -a collection of hydrocarbons that have similar molecular masses and boil at similar temperatures.
Fractional distillation -separating a mixture on the basis of differences in boiling points.
Isomer -a compound having the same molecular formula but different structures.
pH Scale –scale based on hydrogen ion concentration.
Salt an ionic compound made from the reaction of an acid and a base.
Universal Indicator -an indicator that changes colour at each pH value.
Acid rain is formed when air pollutants dioxide are dissolved in rain water.
Acid salts are formed by the incomplete neutralization of an acid.
Alkanes the simplest hydrocarbons in which all carbon-carbon bonds are single.
Alkynes unsaturated hydrocarbons with a carbon-carbon triple bond.
Amino Acids organic compounds containing both amino and carboxyl groups.

Arrhenius Acid a substance that produces H^+ ions in water.
Arrhenious base a substance that produces OH^- ions in water.
Bronsted lowry acid a substance that can donate a proton.
Bronsted lowry base a substance that can accept a proton
Carbohydrates -polyhyroxy aldehydes or ketones.
Catenation -linking of carbon atoms with one another to form long chains or rings of carbon atoms.
Chemical equilibrium -a state of a chemical reaction at which rate of forward reaction equals the rate of reverse reaction.
Concentration -separation of mineral from the gangue.
Crude oil a dark brownish viscous liquid.
Destructive distillation -heating a substance in the absence of air..
Equilibrium constant is the ratio of the product of concentration of products to the product of concentration of reactants each raised to power equal to the coefficient in a balanced chemical equation.
Hydrogenation is addition hydrogen in alkenes and alkynes.
Law of mass action the rate at which a substance reacts is directly proportional to its active mass and the rate at which the reaction proceeds is directly proportional to the product of the active masses of the reactants.
Lewis acid a substance that can accept a pair of electrons.
Lewis base a substance that can donate a pair of electron.
Lipids -any component of plant or animal tissue that is insoluble in water, but soluble in solvents of low polarity such as ether, hexane, benzene and carbon tetrachloride.
Metallurgy is the art of extracting metals from their ores.
Mineral a naturally occurring metallic compound.
Monosaccharides the simple sugars that can not be hydrolyzed.
Normal salts salt formed by the complete neutralization of an acid and a base.
Oligosaccharides carbohydrates that on hydrolysis give 2 to 9 monsaccharide molecules.
Ore a solid deposit containing a sufficiently high percentage of a mineral to make extraction of metal economically feasible.
Ozone an allotropic form of oxygen that contains three oxygen atoms.
Permanent hardness in water is due to the presence of sulphates and chlorides of calcium and magnesium.
Petroleum a dark brownish viscous liquid.
pH is the negative logarithm of molar concentration of the hydrogen ions.
Pollutants are substances that have adverse effect
Polysaccharides -carbohydrates that contain hundreds to thousands of monosaccharide units.
Proteins -organic compounds which on complete hydrolysis form amino acid units.
Refining -a process of separation of crude oil into useful fractions.
Roasting -the heating of concentrated ore in the presence of air.
Smelting -the heating of roasted ore in presence of a reducing agent.
Soft water produces good lather with soap.
Temporary hardness is due to the presence of hydrogen carbonates of calcium and magnesium.

SHORT QUESTION

[Very Important] >> Question: Differentiate between forward and reverse reactions OR Describe the macroscopic characteristics of an equilibrium reaction.

Forward Reaction	Reverse Reaction
• It is written from left to right. • Reactant produce products • Initially rate is fastest and gradually slows down.	• It is written from right to left. • Products produce reactants. • Initially rate is zero and gradually speeds up.

[Important] >> Question: What is chemical equilibrium?
It is a state of a chemical reaction in which forward and reverse reactions take place at the same rate.

[Very Important] >> Question: State the law of Mass Action.
Two chemists **C.M Guldberg** and **P. Waage** in 1864 proposed this law. This law states that the rate at which:

- A substance reacts is directly proportional to its active mass; and
- The reaction proceed is directly proportional to the product of the active masses of the reactants.

[Very Important] >> Question: State the conditions for equilibrium.

i) Concentration of none of the reactants or products is changed.
ii) Temperature of the system is kept constant
iii) Pressure or volume of the system is kept constant.

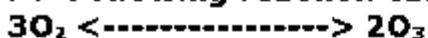
>> Question: What is the importance of equilibrium constant for a chemical reaction?

i) It is used to determine the equilibrium concentration of equilibrium mixture.
ii) It is used to predict the direction of a chemical reaction.
iii) It is used to predict the extent of a chemical reaction.
iv) It is used to predict the effect of change in conditions of the chemical reaction on equilibrium state.

[Important] >> Question: State the ways that equilibrium can be recognized?

- It can be determined by determining concentration of reactants and products at regular intervals.
- When constant concentration of products and reactants are observed, the reaction is at equilibrium.
- This can be done by both physical methods as well as chemical methods such as titration, spectroscopy etc.

>> Following reaction can occur during lightening storms.

$$3O_2 \rightleftharpoons 2O_3$$

For this reaction write

a) Equilibrium Constant Expression.

$$K_c = \frac{[O_3]^2}{[O_2]^3}$$

b) Determine the units of equilibrium constant

$$K_c = \frac{[O_3]^2}{[O_2]^3} = \frac{[mole.dm^{-3}]^2}{[mole.dm^{-3}]^3} = [mole.dm^{-3}]^{-1} = mole^{-1}\,dm^3$$

c) Forward and reverse reactions.

Forward Reaction = $3O_2 \longrightarrow 2O_3$

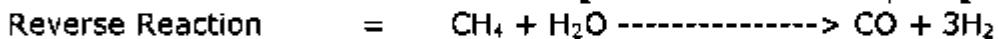
Reverse Reaction = $2O_3 \longrightarrow 3O_2$

Coal reacts with hot steam to form CO and H2. These substances react further in the presence of a catalyst to give methane and water vapour.

$$CO + 3H_2 \rightleftharpoons CH_4 + H_2O$$

a) Write forward and reverse reactions for it.

Forward Reaction = $CO + 3H_2 \longrightarrow CH_4 + H_2O$

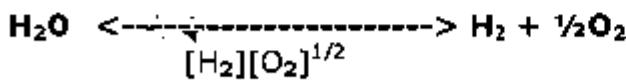
Reverse Reaction = $CH_4 + H_2O \longrightarrow CO + 3H_2$

b) Derive K_c expression for the reaction.

$$K_c = \frac{[CH_4]\,[H_2O]}{[CO]\,[H_2]^3}$$

c) Determine units for Kc.

$$K_c = \frac{[CH_4]\,[H_2O]}{[CO]\,[H_2]^3} = \frac{[mole.dm^{-3}]\,[mole.dm^{-3}]}{[mole.dm^{-3}]\,[mole.dm^{-3}]} = \text{No Unit}$$

It has no unit because total number of moles of reactants is equal to the total number of moles of products.

>> Question: Write equilibrium constant expression for each of the following reactions.

$$H_2O \rightleftharpoons H_2 + \tfrac{1}{2}O_2$$

$$K_c = \frac{[H_2][O_2]^{1/2}}{[H_2O]}$$

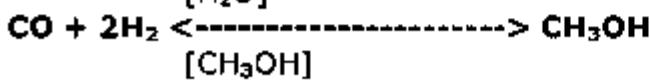
$$CO + 2H_2 \rightleftharpoons CH_3OH$$

$$K_c = \frac{[CH_3OH]}{[CO][H_2]^2}$$

===

$COCl_2$ <---------------------> $CO + Cl_2$

$$K_c = \frac{[COCl_2]}{[COCl_2]}$$

$4HCl + O_2$ <----------------------> $2Cl_2 + 2H_2O$

$$K_c = \frac{[Cl_2]^2[H_2O]^2}{[HCl]^4[O_2]}$$

[Very Important] >> Question: Determine the units of equilibrium constants for the following reactions.

$COCl_2$ <----------------------> $CO + Cl_2$

$$K_c = \frac{[CO][Cl_2]}{[COCl_2]} = \frac{[mole.dm^{-3}][mole.dm^{-3}]}{[mole.dm^{-3}]} = [mole.dm^{-3}]$$

$H_2 + I_2$ <----------------------> $2HI$

$$K_c = \frac{[HI]^2}{[H_2]\,[I_2]} = \frac{[mole.dm^{-3}]^2}{[mole.dm^{-3}]\,[mole.dm^{-3}]} = \text{no unit}$$

$2H_2 + O_2$ <----------------------> $2H_2O$

$$K_c = \frac{[H_2O]^2}{[H_2]^2\,[O_2]} = \frac{[mole.dm^{-3}]^2}{[mole.dm^{-3}]^2\,[mole.dm^{-3}]} = [mole.dm^{-3}]^{-1}$$

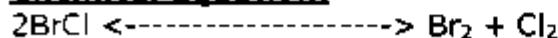
$$= [mole^{-1}.dm^3]$$

$N_2 + 2O_2$ <----------------------> $2NO_2$

$$K_c = \frac{[NO_2]^2}{[N_2]\,[O_2]^2} = \frac{[mole.dm^{-3}]^2}{[mole.dm^{-3}]\,[mole.dm^{-3}]^2} = [mole.dm^{-3}]^{-1}$$

$$= [mole^{-1}.dm^3]$$

[Very Important] >> Question: Bromine chloride (BrCl) decomposes to form chlorine and broine. For this reaction write i) chemical equation ii) K_c expression iii) Units of K_c.

Chemical Equation:

$2BrCl$ <-------------------> $Br_2 + Cl_2$

Kc Expression:

$$K_c = \frac{[Br_2][Cl_2]}{[BrCl]^2}$$

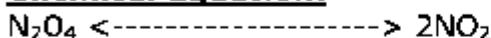
Units of K_c:

$$K_c = \frac{[Br_2][Cl_2]}{[BrCl]^2} = \frac{[mole.dm^{-3}][mole.dm^{-3}]}{[mole.dm^{-3}]^2} = \text{no unit}$$

[Very Important] >> Question: K_c expression for a reaction is given below. Write chemical equation for this reaction and derive the units of K_c.

$$K_c = \frac{[NO_2]^2}{[N_2O_4]}$$

Chemical Equation:

N_2O_4 <--------------------> $2NO_2$

Unit of K_c:

$$K_c = \frac{[NO_2]^2}{[N_2O_4]} = \frac{[mole.dm^{-3}]^2}{[mole.dm^{-3}]} = [mole.dm^{-3}]$$

[Important] >> Question: Cobalt chloride forms pink crystals ($CoCl_3.6H_2O$). When they are heated water is evolved and they turn blue ($CoCl_3$). Explain how you could use Cobalt chloride as a test for water.

$CoCl_3.6H_2O$ <------------------------> $CoCl_3 + 6H_2O$

- Anhydrous cobalt chloride paper is blue. But in water or any sort of moisture it starts to turn pink.
- So if we are using it keep out of air. And don't touch it with your hands because the moisture on your fingers would change the outcome of your cobalt chloride paper.

[Important] >> Question: Define complete reaction

A complete reaction is one in which all reactants have been converted to products.

[Very Important] >> Question: An understanding of equilibrium is important in the chemical industry why?

Equilibrium reactions are involved in some of the stages in the commercial production of many important chemicals such as ammonia, sulphuric acid etc.

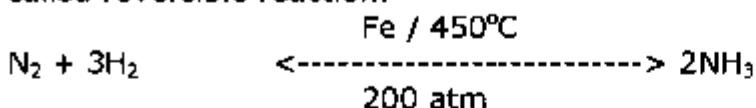
[Very Important] >> Question: What happens when some liquid is placed in a closed container?

OR

>> What is Reversible Reactions and Dynamic Equilibrium?

Some of the liquid undergoes a physical change by evaporating. As more liquid evaporates, some of the vapours condense due to collision with the surface of the liquid. Eventually the rate of evaporation equals the rate of condensation. At this stage equilibrium is established between forward and reverse changes.

[Very Important] >> Question: Define reversible reaction with examples.
A reaction in which the products can react together to reform the original reactants is called reversible reaction.

$$N_2 + 3H_2 \xrightleftharpoons[200\ atm]{Fe\ /\ 450^{o}C} 2NH_3$$

[Important] >> Question: Define equilibrium mixture
The concentrations of reactants and products are called equilibrium concentrations and the mixture is called equilibr um mixture.

[Important] >> Question: What do you know about formation of fizzy drinks? How this process interact with Equilibrium mixture.
When fizzy drinks are made, CO_2 is dissolved in liquid drink under pressure and sealed. The forward reaction happens during manufacturing and reverse reaction happens on opening.

>> Question: What happens when SO_2 and O_2 gases are mixed in a sealed container?
Molecules of SO_2 and O_2 react to give SO_3. Molecules of SO_3 decomposes to give SO_2 and O_2.

[Important] >> Question: Define Active Mass.
The term active mass represents the concentration of reactants and products in moles dm^{-3} for a dilute solution, and is expressed in terms of square brackets [].

[Very Important] >> Question: Define Equilibrium Constant (K_c)
It is defined as the ratio of the product of concentration of products to the product of concentration of reactants each raised to the power equal to the coefficient in the balanced chemical equation.

>> What happens when we add water to concentrated sulphuric acid?
The addition of water to the concentrated sulphuric acid produces a vigorous reaction, which often causes acid droplets to spew in all directions. For this reaction this must be avoided. Always add the acid to water when diluting it.

[Very Important] >> Define Le Chatellier's principle
If you impose a change in concentration, temperature or pressure on a chemical system at equilibrium, the system responds in a way that opposes the change.

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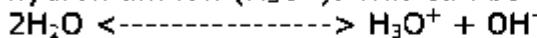
SHORT QUESTION

[Important] >> Question: What is Self Ionization of Water? Write the equation for self ionization of water?
The reaction in which two water molecules produce ions is called as the self-ionization or auto ionization of water. Simple ionization of water can be written as:
H_2O <----------------> H^+ + OH^-

A water molecule that loses a proton becomes a negatively charged hydroxide ion (OH^-). The other water molecule which gains the proton becomes positively charged hydronium ion (H_3O^+). This can be written as:
$2H_2O$ <----------------> H_3O^+ + OH^-

[Important] >> Question: Define and give examples of Arrhenius acids.
An acid is a substance that ionizes in water to produce H^+ ions. For example:

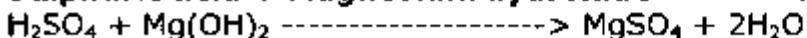
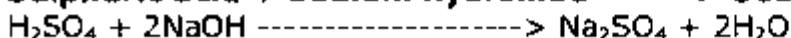
HCl <----------------> H^+ + Cl^-
H_2O
HNO_3 <----------------> H^+ + NO_3^{-1}

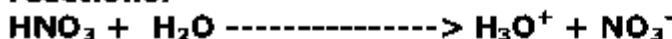
[Very Important] >> Question: Why H^+ ion acts as a Lewis acid?
A Lewis acid is a lone pair acceptor, the H^+ ion has no electrons, so can easily accept a lone pair from another atom. That is why H^+ ion acts as a Lewis acid.

[Very Important] >> Question: Why NH_3 acts as Bronsted-Lowry base?.
Water is proton donor and ammonia is proton accepter. Therefore water acts as an acid and ammonia as a base.

[Very Important] >> Question: Why BF_3 acts as Lewis acid?
Boron in BF_3 has incomplete octet. It has six electrons. So it needs an electron pair to complete its octet. Hence BF_3 is an electron pair accepter or Lewis acid.

>> Question: Ammonium hydroxide and nitric acid react and product ammonium nitrate and water. Write balanced chemical equation for this neutralization reaction.
NH_4OH + HNO_3 --------------------------> NH_4NO_3 + H_2O

[Very Important] >> Question: Write balanced chemical equations for the following neutralization reactions.
Sulphuric acid + Magnesium hydroxide -------> Magnesium sulphate + water
H_2SO_4 + $Mg(OH)_2$ --------------------> $MgSO_4$ + $2H_2O$
Sulphuric acid + Sodium hydroxide -------> Sodium sulphate + water
H_2SO_4 + 2NaOH --------------------> Na_2SO_4 + $2H_2O$
Hydrochloric acid + Calcium Hydroxide -------> Calcium Chloride + water
2HCl + $Ca(OH)_2$ --------------------> $CaCl_2$ + $2H_2O$

>> Question: Identify Bronsted-Lowry acids or bases in the following reactions.

HNO_3 + H_2O ---------------> H_3O^+ + NO_3^-

- Since HNO_3 is converted to NO_3^- by donating proton therefore HNO_3 is an acid.
- Since H_2O accepts the proton that HNO_3 donates and forms H_3O^+, water is a base.

NH_3 + HNO_3 ---------------> NH_4NO_3

- Since HNO_3 is converted to NO_3^- by donating proton therefore HNO_3 is an acid.
- Since NH_3 accepts the proton and forms NH_4^+ so it is a base.

>> Question: Identify Lewis acid and Lewis base in the following reactions.

F^- + BF_3 ---------------> $[BF_4]^-$

- F^- has a lone pair on F-atom. So it is electron pair donor. F^- is a Lewis base.
- Boron in BF_3 has incomplete octet. It has six electrons, so it needs an electron pair to complete its octet. Hence BF_3 is an electron pair accepter or Lewis acid.

H^+ + NH_3 ---------------> $[NH_4]^-$

- A Lewis acid is a lone pair acceptor, the H^+ ion has no electrons, so can easily accept a lone pair from another atom. Therefore H^+ ion acts as a Lewis acid.
- NH_3 has a lone pair on N-atom. So it is electron pair donor. So, NH_3 is a Lewis base.

NH_3 + $AlCl_3$ ---------------> $[H_3N - AlCl_3]$

- In $AlCl_3$, Al is deficient of two electrons. Therefore it will be called Lewis acid.
- NH_3 contains a lone pair and can be donated to $AlCl_3$ and hence it will act as Lewis base.

[Very Important] >> Question: Classify the following solutions as acidic, basic or neutral.

i) A solution that has hydrogen ion concentration 1.0×10^{-3} M.

$[H^+] = 1.0 \times 10^{-3}$ M > 1.0×10^{-7} M = So, solution is acidic.

ii) A solution that has hydrogen ion concentration 1.0×10^{-10} M.

$[H^+] = 1.0 \times 10^{-10}$ M < 1.0×10^{-7} M = So, solution is basic.

iii) A solution that has hydroxyl ion concentration 1.0×10^{-3} M.

$[H^+]$ = ?

Kw = $[H^+][OH^-]$

$1.0 \times 10^{-14} = [H^+]1.0 \times 10^{-3}$

$$[H^+] = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-3}} = 1.0 \times 10^{-11}$$

$[H^+] = 1.0 \times 10^{-11}$ M < 1.0×10^{-7} M = So, solution is basic.

===

iv) A solution that has hydroxyl ion concentration 1.0×10^{-10} M.

$[H^+]$ = ?

Kw = $[H^+][OH^-]$

$1.0 \times 10^{-14} = [H^+]1.0 \times 10^{-10}$

$$[H^+] = \frac{1.0 \times 10^{-14}}{1.0 \times 10^{-10}} = 1.0 \times 10^{-4}$$

$[H^+] = 1.0 \times 10^{-4}$ M > 1.0×10^{-7} M = So, solution is acid.

>> Question: Classify following substance as Lewis acid and bases. NH_3, F^-, H_2O, BF_3

i) Since NH_3 accepts the proton and forms NH_4^+ so it is a base.

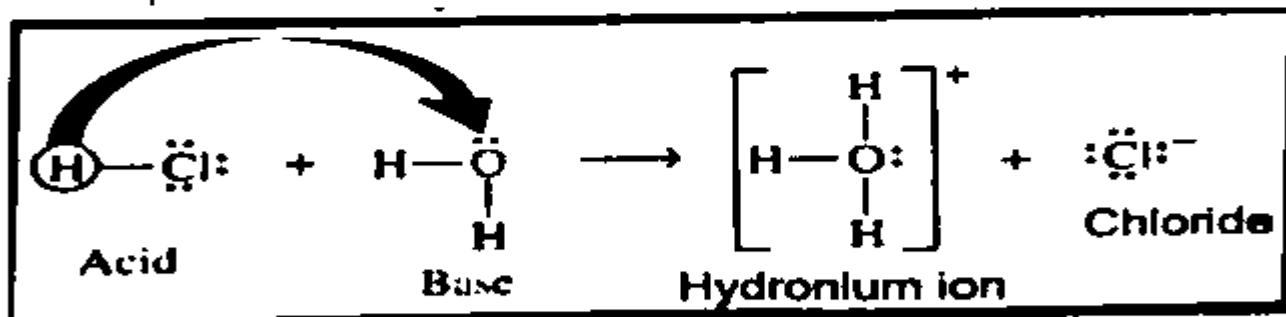
ii) F^- has a lone pair on F-atom. So it is electron pair donor. F- is a Lewis base.

iii) Since H_2O donate a proton therefore H_2O is an acid.

iv) Boron in BF_3 has incomplete octet. It has six electrons. So it needs an electron pair to complete its octet. Hence BF_3 is an electron pair accepter or Lewis acid.

[Important] >> Question: Give the Bronsted-Lowry definition of an acid.

In 1923 J.N Bronsted and T.M Lowery independently proposed another theory to overcome the shortcomings of Arrhenius theory. According to Bronsted-Lowry theory an acid is a proton donor.

For example:

>> Question: Give the Bronsted-Lowry definition of a base. Write an equation that illustrates the definition.

According to Bronsted-Lowry theory a base is a proton accepter.

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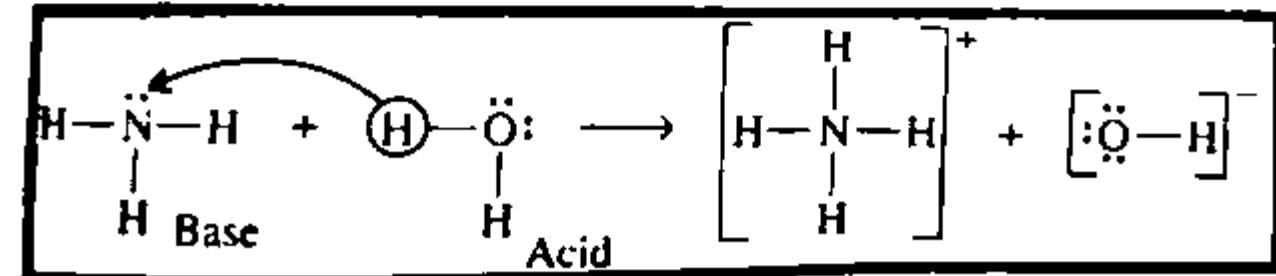
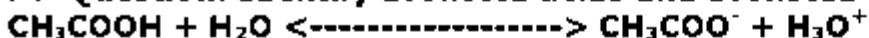
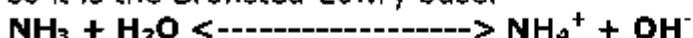
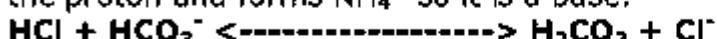

>> Question: Identify Bronsted acids and Bronsted bases in the following

$CH_3COOH + H_2O \longleftrightarrow CH_3COO^- + H_3O^+$

Because CH_3COOH is converted to CH_3COO^- by donating proton therefore CH_3COOH is an acid.

$CHO_3^- + H_2O \longleftrightarrow CO_3^{-2} + H_3O^+$

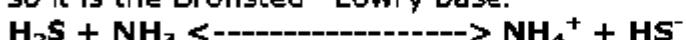
The HCO_3^- loses an H^+ ion, so it is the Bronsted-Lowry acid. The H_2O gains the H^+ ion, so it is the Bronsted-Lowry base.

$NH_3 + H_2O \longleftrightarrow NH_4^+ + OH^-$

H_2O is converted to OH^- by donating a proton, so H_2O is an acid. Because NH_3 accepts the proton and forms NH_4^+ so it is a base.

$HCl + HCO_3^- \longleftrightarrow H_2CO_3 + Cl^-$

The HCL loses an H+ ion, so it is the Bronsted-Lowry acid. The HCO3- gains the H+ ion, so it is the Bronsted-Lowry base.

$HS^- + H_2O \longleftrightarrow S^{-2} + H_3O^+$

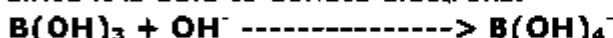
The HS^- loses an H^+ ion, so it is the Bronsted-Lowry acid. The H_2O gains the H^+ ion, so it is the Bronsted –Lowry base.

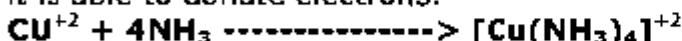
$H_2S + NH_3 \longleftrightarrow NH_4^+ + HS^-$

H_2S is donating a proton, so H_2S is an acid. Because NH_3 accepts the proton and forms NH_4^+ so it is a base.

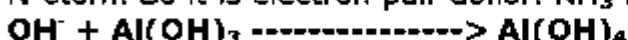
>> Question: Identify the Lewis acids and the Lewis bases in the following reactions.

$Ag^+ + 2CN^- \longrightarrow Ag(CN_2)$

Cations Ag^+ is Lewis acid since it is able to accept electrons. Anion CN^- is Lewis base since it is able to donate electrons.

$B(OH)_3 + OH^- \longrightarrow B(OH)_4^-$

B(OH)3 is Lewis acid since it is able to accept electrons. Anion OH^- is Lewis base since it is able to donate electrons.

$CU^{+2} + 4NH_3 \longrightarrow [Cu(NH_3)_4]^{+2}$

Cations Cu^{+2} is Lewis acid since it is able to accept electrons. NH_3 has a lone pair on N-atom. So it is electron pair donor. NH_3 is Lewis base since it is able to accept

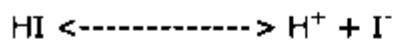
$OH^- + Al(OH)_3 \longrightarrow Al(OH)_4^-$

$Al(OH)_3$ is Lewis acid since it is able to accept electrons. Anion OH^- is Lewis base since it is able to donate electrons.

>> Question: Identify Lewis acids and bases from the following

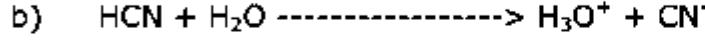
$AlCl_3$	$AlCl_3$ is Lewis acid since it is able to accept electrons.
Ag^+	Ag^+ is Lewis acid since it is able to accept electrons.
CN^-	Anion CN^- is Lewis base since it is able to donate electrons.
OH^-	Anion OH^- is Lewis base since it is able to donate electrons.
$FeCl_3$	$FeCl_3$ is Lewis acid since it is able to accept electrons.
$C_{18}H_{21}NO_3$	Codeine ($C_{18}H_{21}NC_3$) is commonly prescribed as pain killer. It dissolves in water by following reaction. $C_{18}H_{21}NO_3 + OH^- \longleftrightarrow [C_{18}H_{21}HNO_3]^+ + OH^-$ It is Lewis acid since it is able to accept electrons.

>> Question: Write equations showing the ionization of following as Arrhenius acids.

a) HI b) HNO_2

HI <-------------> $H^+ + I^-$
HNO_2 <-------------> $H^+ + NO_2^{-1}$

>> Question: Write equations showing the ionization of the following as Bronsted-Lowry acids.

a) HNO_2 b) HCN

a) $HNO_2 + H_2O$ -----------------> $H_3O^+ + NO^-$
- Since HNO_2 converted to NO^- by donating proton therefore HNO_2 is an acid.
- Since H_2O accepts the proton that HNO_2 donates and form H_3O^+, water is base.

b) HCN + H_2O -----------------> $H_3O^+ + CN^-$
- Since HCN converted to CN^- by donating proton therefore HCN is an acid.
- Since H_2O accepts the proton that HCN donates and form H_3O^+, water is base.

>> Question: What is true about the relative concentration of hydrogen ions and hydroxide ions in each kind of solution? a) acidic b) basic c) neutral

a) $[OH^-] < [H^+]$
b) $[OH^-] > [H^+]$
c) $[OH^-] = [H^+]$

[Important] >> Question: Suggest some ways in which you might determine whether a particular water solution contains an acid or a base.

Litmus paper is one way. An indicator solution, like phenolphthalein, would also work. A pH meter, too.

>> Question: Bacteria in our mouth feed on small particles of food stuck to our teeth and change it into acid. Explain how using toothpaste of pH 10 can help to prevent the acid from damaging our teeth?

Toothpaste of pH 10 mildly alkaline. The alkaline pH of toothpaste helps to neutralize the plaque acids which cause tooth decay.

[Important] >> Question: What is acid rain?

Sulfur dioxide and nitrogen oxides are the primary causes of acid rain. Acid rain occurs when these gases react in the atmosphere with water, oxygen and other chemicals to form various acidic compounds.

[Important] >> Question: Give the Arrhenius concept of acids and bases?

In 1887, a Swedish chemist Svante Arrhenius proposed the first successful theory of acids and bases. According to him:
- An acid is a substance that ionizes in water to produce H^+ ions.
- A base is a substance that ionizes in water to produces OH^- ions.

[Very Important] >> Question: What are the applications of pH measurement?

It helps analytical chemists to:

- Create soil conditions ideal for plant growth
- Medical diagnose
- Maintaining the correct acid base balance in swimming pools
- Electroplating
- Manufacture of medicine etc

[Important] Question: Write uses of some common acids.

Hydrochloric acid (HCl):

Cleaning of metals, bricks and removing scale from boilers.

Nitric Acid (HNO_3):

Manufacture of fertilizers, explosives

Sulphuric Acid (H_2SO_4):

Manufacture of many chemicals, drugs, dyes, paints and explosives

Phosphoric acid (H_3PO_4):

Manufacture of fertilizers, acidulant for food.

[Important] Question: Write uses of some common bases.

Sodium hydroxide (NaOH):

Soap making, drain cleaners

Potassium hydroxide (KOH):

Making liquid soap, shaving cream

Calcium hydroxide [$Ca(OH)_2$]:

Making mortar, plasters, cement

Magnesium hydroxide [($Mg(OH)_2$]:

Antacid, laxative

[Very Important] Question: What are the limitations of Arrhenius theory?

Arrhenius theory has its limitations. It applies to aqueous solutions. It does not explain why compounds such as CO_2, SO_2 etc., are acids. Why substances like NH_3, are bases? There is no H in CO_2 and OH in NH_3.

Dissatisfaction (Defects) of Arrhenius theory:

- There are certain substances which do not give H^+ ions but still they are acidic in solution e.g. $AlCl_3$
- There are substances which do not give OH^- ions in H_2O but are basic in nature e.g. NH_3

[Very Important] Question: What do you mean by amphoteric substances?

Water molecules accepts a proton and in the other water donates a proton. This means water behaves like an acid as well as base. It is amphoteric in nature. Substances that react with both acids and bases are called amphoteric substances.

[Very Important] Question: What are the limitations of Lowry-Bronsted Concept?

Bronsted-Lowry concept is also not so comprehensive because following this concept, certain compounds cannot be considered as acid or bases although the act as acids or bases. For example, sulphur trioxide (SO_3) is a base but it cannot accept proton.

Question: List the substances that cannot be explained by Arrhenius theory or the Bronsted-Lowry theory?

Certain substances like SO_2, CO_2, CaO, BF_3 etc. behave as acids or bases although they do not have ability to donate or accept protons. Nature of such substances cannot be explained by Arrhenius theory or the Bronsted-Lowry theory.

[Important] Question: Give the Lewis definition of Acid and Base.

IN 1923 G.N. Lewis proposed and acid base theory. This concept is more general than Arrhenius or Bronsted-Lowry theory.

- A **Lewis acid** is substance that can accept a pair of electrons to form a coordinate covalent bond.
- A **Lewis base** is substance that can donate a pair of electrons to form a coordinate covalent bond.

[Important] Question: Write the equation for the self ionization of water?

The reaction in which two water molecules produce ions is called self ionization of water. This reaction can be written as a simple ionization of water:

H_2O <-----------------------> $H^+ + OH^-$

[Very Important] Question: Define pH and pOH

- **pH** is defined as negative logarithm of the molar concentration of H^+ ions in aqueous solution.
- **pOH** is defined as the negative logarithm of the molar concentration of OH^- ions in aqueous solution.

[Very Important] Question: What is importance of K_w?

K_w is temperature dependent. In any aqueous solution at 25°C, no matter what does it contain the product of H^+ ion concentration and OH^- ion concentration is always equal to 1.0×10^{-14}. This means that if H^+ increases, the OH^- must decrease so that the product of two is still 1.0×10^{-14}.

[Important] Question: What do you mean by pH scale?

Chemists use a number scale from 0 to 14 to describe the concentration of H+ ions in a solution. It is known as pH scale.

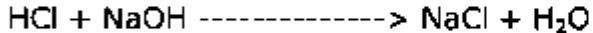
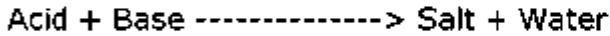
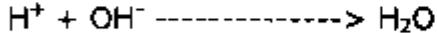
- A pH of 7 indicates a neutral solution.
- Acids have pH less than 7.
- Bases have pH greater than 7.

Question: At what pH phenolphthalein changes its color?
Phenolphthalein works in a pH range of 8.2 to 10.0. The color change is from colorless to red/fuchsia.

Question: At what pH bromothymol blue changes color from yellow to blue?
Bromothymol blue is a pH indicator. This indicator is yellow when pH is below 6.0. It is blue when the pH of the solution is above 7.6.

Question: What are salts?
An acid contains replaceable hydrogen atoms. When these are completely or partially replaced by metal atoms, a compound called salt is formed. Salts are ionic compounds. First part of name indicates the metal ion while second part indicates the name of negative part of acid. For example Sodium chloride.

[Very Important] Question: What is Etching?
Etching is an art that uses acid to crave patterns into metal, glass and other materials. For this a piece of metal or glass is covered with wax, and then a design is etched on to the plate through the wax. The plate is then dipped into a tank of acid. The acid eats away at the exposed portion, which leaves behind textured mark. The plate is then taken out of the acid and cleaned. Ink can also be applied on etching to create colorful design.

Question: Briefly explain neutralization.
Reaction between an acid and a base is called neutralization reaction.
Acid + Base --------------> Salt + Water
HCl + NaOH --------------> NaCl + H_2O

Neutralization is the reaction between H+ ions of an acid and OH- ions of a base.
H^+ + OH^- --------------> H_2O

[Important] Question: Define Basic Salt?
A salt containing replaceable OH group or formed by the partial neutralization of a polyhydroxy base is called basic salt.

[Important] Question: Differentiate between normal salt and acid salt?
A salt containing a replaceable H-atom or formed by partial neutralization of an acid is called acid salt whereas a salt which is formed by the complete neutralization of an acid is called a normal salt.

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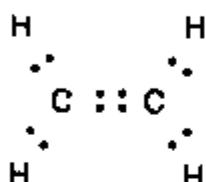
SHORT QUESTION

>> Question: Give three examples of unsaturated hydrocarbons?

Ethene:	Pentene	Butyne
H H C = C H H	H H H H H C = C – C – C – C – H H H H H	H H H – C – C ≡ C – C – H H H

>> Question: Draw electron dot and cross structure for ethane.

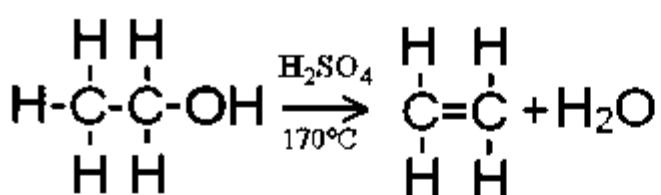
H H
C :: C
H H

>> Question: Draw structural formula of an alkane, an alkene and an alkyne containing five carbon atoms.

Pentane:	Pentene	Pentyne
H H H H H H – C – C – C – C – C – H H H H H H	H H H H H C = C – C – C – C – H H H H H	H H H H – C – C – C – C ≡ C – H H H H

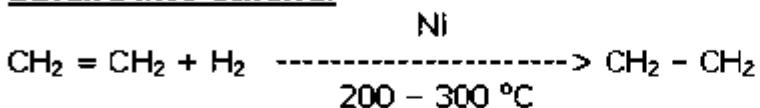
>> Question: How can you differentiate between ethane from ethene?

- Add a small amount of bromine water to each jar.
- Shake the jar containing ethane will de-color the bromine water.
- The jar containing the ethane the bromine water will remain brown.
- This is because the Br_2 will add on across the double bond of the unsaturated ethane to produce dibromoethane.
- The Br_2 is removed from the water which becomes clear.
- In the case of ethane this is already saturated, so no reaction occurs – Bromine water remains brown.

>> Question: What do you mean by dehydration reaction? Give one example
Dehydration means loss of water.
Example:
Alcohols dehydrate when their vapour are passed over heated alumina.

$$H_3C\text{-}CH_2\text{-}OH \xrightarrow[170^\circ C]{H_2SO_4} H_2C{=}CH_2 + H_2O$$

>> Question: How can you convert?

Ethene into ethane:

$$CH_2 = CH_2 + H_2 \xrightarrow[200 - 300\ ^\circ C]{Ni} CH_2 - CH_2$$

Methane into Carbon tetrachloride:

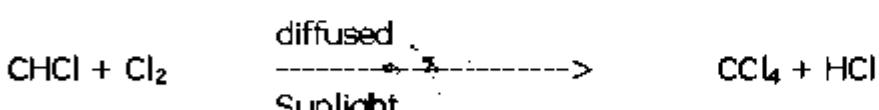
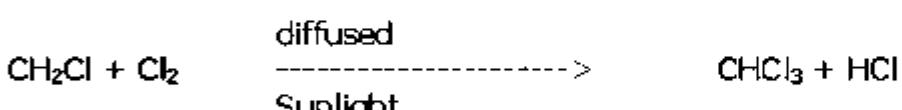
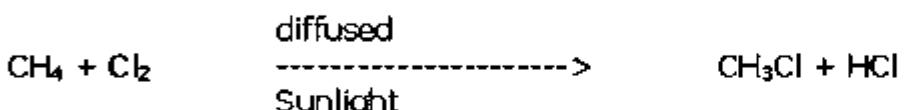
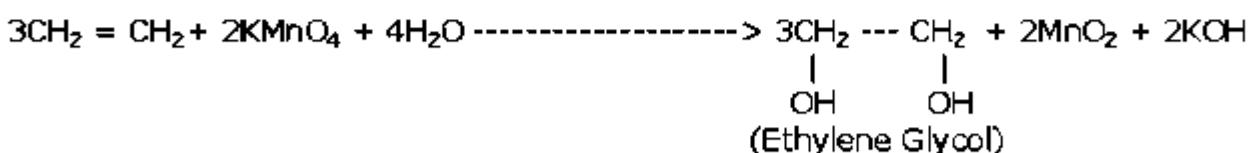
$$CH_4 + Cl_2 \xrightarrow[\text{Sunlight}]{\text{diffused}} CH_3Cl + HCl$$

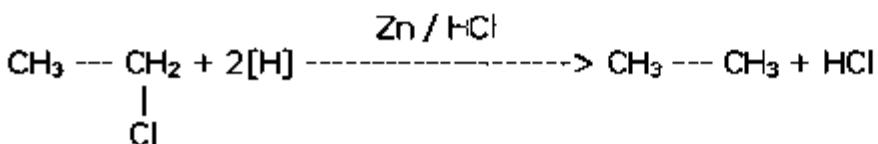
$$CH_3Cl + Cl_2 \xrightarrow[\text{Sunlight}]{\text{diffused}} CH_2Cl_2 + HCl$$

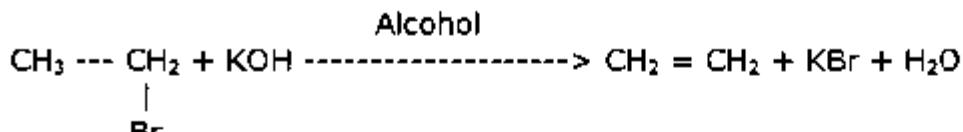
$$CH_2Cl + Cl_2 \xrightarrow[\text{Sunlight}]{\text{diffused}} CHCl_3 + HCl$$

$$CHCl + Cl_2 \xrightarrow[\text{Sunlight}]{\text{diffused}} CCl_4 + HCl$$

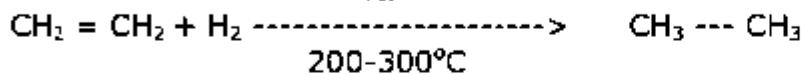
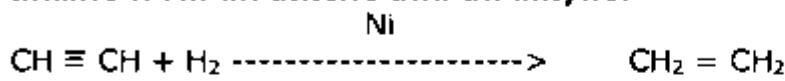
Ethene into glycol:

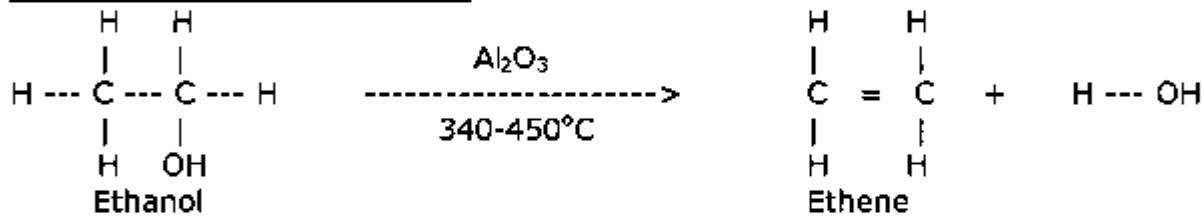
$$3CH_2 = CH_2 + 2KMnO_4 + 4H_2O \longrightarrow 3CH_2(OH) - CH_2(OH) + 2MnO_2 + 2KOH$$

(Ethylene Glycol)

Ethyl Chloride into ethane:

$$CH_3 - CH_2Cl + 2[H] \xrightarrow{Zn\ /\ HCl} CH_3 - CH_3 + HCl$$

Ethyl bromide into ethene:

$$CH_3 - CH_2(Br) + KOH \xrightarrow{Alcohol} CH_2 = CH_2 + KBr + H_2O$$

>> Question: Write a chemical equation to show the preparation of an alkane from an alkene and an alkyne.

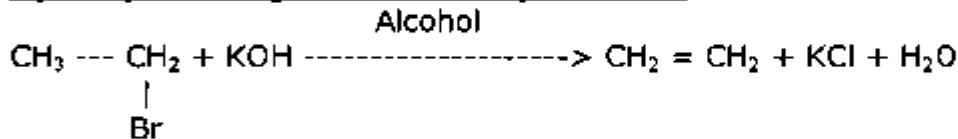
$$CH \equiv CH + H_2 \xrightarrow[200\text{-}300^\circ C]{Ni} CH_2 = CH_2$$

$$CH_2 = CH_2 + H_2 \xrightarrow[200\text{-}300^\circ C]{Ni} CH_3 - CH_3$$

>> Question: Write a chemical equation to show the preparation of ethane from dehydration of an alcohol and dehydrohalogenation of alkyl halides.

By Dehydration of Alcohols:

$$H - C(H)(H) - C(H)(OH) - H \xrightarrow[340\text{-}450^\circ C]{Al_2O_3} C(H)(H) = C(H)(H) + H - OH$$

Ethanol → Ethene

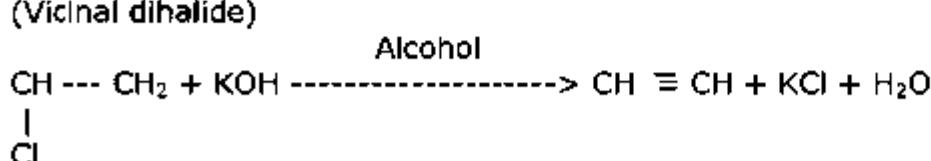
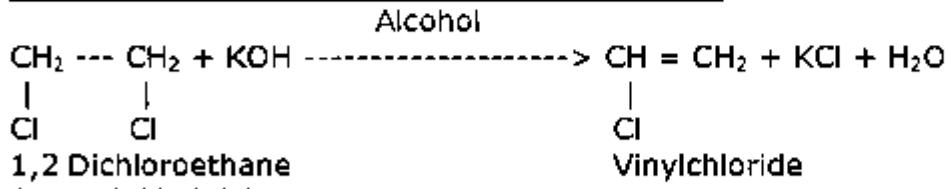
By dehydrohalogenation of alkyl halides:

$$CH_3 - CH_2(Br) + KOH \xrightarrow{Alcohol} CH_2 = CH_2 + KCl + H_2O$$

>> Question: Write a chemical equation to show the preparation of ethyne from dehalogenation of 1, 2 – dihalide and a tetrahalide.

By dehydrohalogenations of 1,2 – dihalide:

$$CH_2(Cl) - CH_2(Cl) + KOH \xrightarrow{Alcohol} CH(Cl) = CH_2 + KCl + H_2O$$

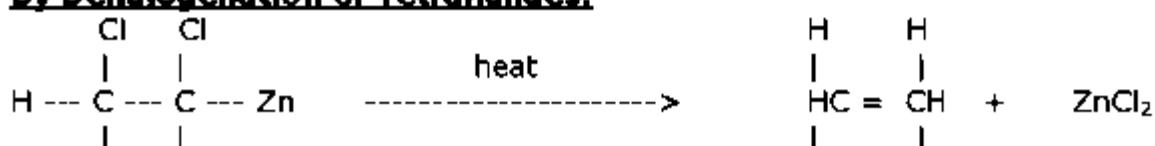
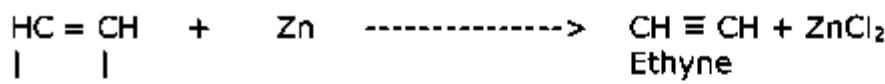
1,2 Dichloroethane (Vicinal dihalide) → Vinylchloride

$$CH(Cl) - CH_2 + KOH \xrightarrow{Alcohol} CH \equiv CH + KCl + H_2O$$

By Dehalogenation of Tetrahalides:

$$H - C(Cl) - C(Cl) - Zn \xrightarrow{heat} HC(H) = CH(H) + ZnCl_2$$

Cl Cl
1,1,2,2-Tetrachloroethane

Cl Cl
1,2-Cichloroethene

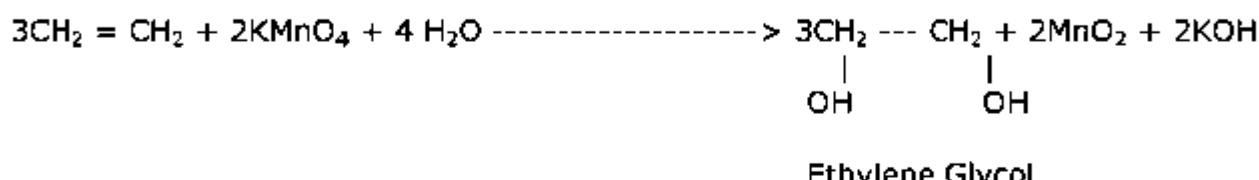
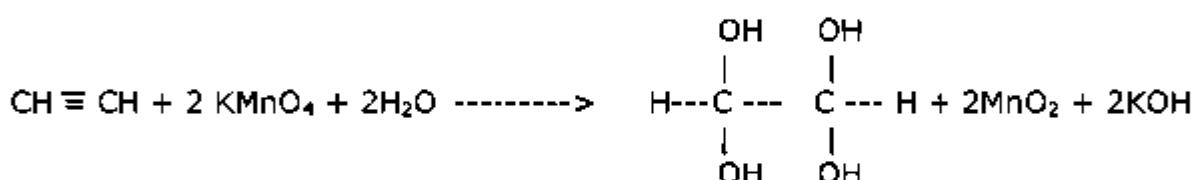
HC = CH + Zn ---------------> $CH \equiv CH + ZnCl_2$
| |
Cl Cl
Ethyne

>> Question: Write chemical equation showing reactions of $KMnO_4$ with ethene and ethyne.

Reaction with Ethene:

$3CH_2 = CH_2 + 2KMnO_4 + 4 H_2O$ --------------------> $3CH_2$ --- $CH_2 + 2MnO_2 + 2KOH$
| |
OH OH

Ethylene Glycol

Reaction with Ethyne:

OH OH
| |
$CH \equiv CH + 2 KMnO_4 + 2H_2O$ ---------> H---C --- C --- H + $2MnO_2$ + 2KOH
| |
OH OH

>> Question: List some industrial uses of ethene and ethyne.

Uses of Ethene:

- Ethene is used to accelerate the ripening of fruits and is most commonly used on bananas and also on citrus fruit.
- The other use of ethene is in the manufacture of plastics, such as packing films, wire coatings, and squeeze bottles.

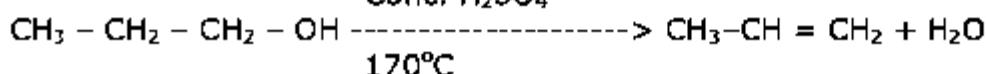
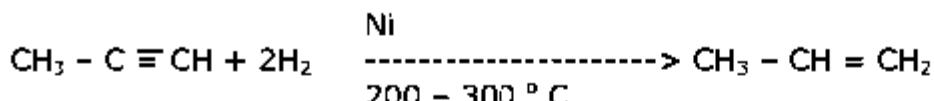
Uses of Ethyne:

- In oxy-acetylene torch for welding and cutting metals.
- For ripening of fruits.
- For the manufacture of polyvinyl acetate (PVA), polyvinyl chloride (PVC), polyvinyl ethers and rubbers.

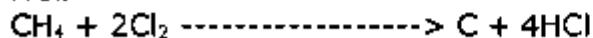
>> Question: Explain why a systematic method of naming chemical compounds is necessary.

An international body, the International Union of Pure and Applied chemistry (IUPAC) constantly reviews the rules for naming organic compounds. IUPAC system of naming organic compounds is based on the following principle.

>> Question: Write chemical equations for the preparation of propene from:

$$CH_3 - CH_2 - CH_2 - OH \xrightarrow[170^oC]{Conc.\ H_2SO_4} CH_3-CH = CH_2 + H_2O$$

$$CH_3 - C \equiv CH + 2H_2 \xrightarrow[200 - 300\,^{\circ}C]{Ni} CH_3 - CH = CH_2$$

>> Question: What are hydrocarbons?
Binary compounds of hydrogen and carbon are called hydrocarbon.
>> Question: Why are some fuels called as fossil fuels?
Some fuels are called fossil fuels because, like fossils they were formed long time ago. Oil is an example of fossil fuel.
>> Question: Write the causes of global warming?
Carbon dioxide and other gases produce a greenhouse effect. About 25 billion tons of carbon dioxide is released into the atmosphere each year, 22 billion tons of it comes from the brining of fossil fuels. About 15 billion tons per year is removed by the plants. Thus 10 billion tons of carbon dioxide remains in the air. This is causing global warming.
>> Question: Write down the importance of alkene polymers.
- Alkenes are starting materials for the synthesis of many valuable materials.
- Our clothes, carpets, curtains, towels are polymers made from ethene and ethyne.
- Hydrocarbons are also used as raw materials for the synthesis of synthetic rubber, plastic, films, adhesives, drugs and dyes.
- In the field of medicine, body replacement parts are made from polymers.
- We can also expect to have artificial lungs and artificial hearts.

>> Question: Is there anything that can replace petroleum as raw material for making plastics and other polymers.
Vats of blue green algae could one day replace oil wells in producing raw materials for chemical industry.
>> Question: Alkynes add two molecules of hydrogen. Why?
Alkynes add two molecules of hydrogen to convert alkynes into alkanes.
>> Question: List some properties of alkanes?
- Alkane molecules are essentially non-polar.
- Alkanes are less dense than water and insoluble in it.
- Chemically alkanes are unreactive towards most ionic compounds.
- Higher alkanes are solids which are also colorless and odorless.

>> Question: What happens when methane is treated with chlorine in the presence of bright sun light?
In direct sunlight, reaction of methane and chlorine is explosive and forms carbon and HCl.
$CH_4 + 2Cl_2$ ------------------> $C + 4HCl$
>> Question: Describe the trends in reactivity of halogen with alkances?
$F_2 > Cl_2 > Br_2 > I_2$
>> Question: List uses of methane?
It is used as domestic fuel (sui gas)
It is used as a fuel for automobiles (CNG)

It is used to manufacture urea fertilizers.

>> Question: What is combustion of methane?
A reaction of a substance with oxygen or air that causes the rapid release of heat and the appearance of a flame is called combustion. Complete combustion produces carbon dioxide, water and heat.

>> Question: List the properties of alkenes?
- Alkenes are unsaturated hydrocarbons.
- First three members i.e. ethene, propene and butane are gases while C_5-C_{15} members are liquids and the higher members are solid.
- They are insoluble in water but soluble in organic solvents such as alcohol etc.

>> Question: What is use of Ethylene glycol?
It is used as an anti-freeze.

>> Question: What are oxy-acetylene torches?
Acetylene is used in oxy-acetylene torches for cutting and welding metals. Such torches can produce temperature as high as 3000°C.

>> Question: List the properties of alkynes?
- Alkynes are unsaturated hydrocarbons.
- They are non-polar and dissolve readily in organic solverts.
- Ethyne has garlic like odour.
- One molecule adds across the double bond in an addition reaction.
- Alkynes also undergo addition reactions like alkene.

>> Question: How can one identify the unsaturation in a molecule?
Bromine is a reddish brown liquid and the product is colorless. When bromine water is added to an ethyne, the red-brown color disappears. The decolonization of bromine solution is frequently used as a simple test for the presence of unsaturation.

>> Question: What is combustion reaction?
Natural gas, petroleum and coal are important sources of hydrocarbons. These hydrocarbons are major sources of energy. When they burn in air a highly exothermic reaction occurs. This reaction is called combustion reaction. We use hydrocarbons as fuel to meet energy needs in homes, industries, vehicles and power generation.

>> Question: What are the uses of halogenated hydrocarbons?
Many halogenated hydrocarbons have important commercial uses. Methyl chloride is a gas at room temperature. Dichloromethane, tri-chloromethane and tetra chloromethane are liquids. These three liquids can be used a solvents for grease, oils and other organic substances. Chloroform is used as an anesthetic. Tetra-chloromethane has carcinogenic affects at high concentration.

>> Question: What do you know about Baeyer's test?

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1 % alkaline aqueous solution of $KMnO_4$ is used to detect the presence of an alkene. The reaction is known as Baeyer's test.

>> Question: What is Vicinal Dihalide?

A vicinal dihalide has two halogen atoms on adjacent carbon atoms.

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SHORT QUESTION

>> Question: Decide whether sucrose is a disaccharide or monosaccharide. Give reason?

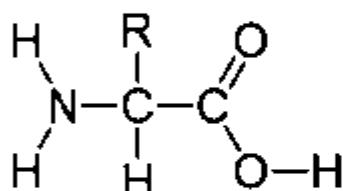
Since Sucrose consists of two monomers, therefore sucrose is a disaccharide. (which we call table sugar, cane sugar, or "sugar" itself). Sucrose is a disaccharide of glucose and fructose.

>> Question: What is a dextrose sugar?

Some monosaccharide molecules can rotate the plane of plane polarized light to right (clockwise). They are called dextro-rotatory or dextrose sugars. Glucose, manose, galactose are dextrose sugars.

>> Question: Write the formula of an amino acid and identify functional groups in it.

An amino acid has two functional groups. All amino acids have a carboxyl and amino group in order for them to form long continuous chains of proteins. Structure of amino acid is as follows:

```
H     R     O
 \    |    //
  N — C — C
 /    |    \
H     H     O—H
```

>> Question: What is peptide bond?

```
              O
              ||
The linkage – C – NH – which joins two amino acids units is called a peptide bond.
```

The resulting molecule is called dipeptide.

>> Question: Which compounds are included in lipids?

- Fats and oils
- Cholesterol
- Reproductive hormones
- Components of cell membrane called phospholipids.
- Some vitamins (A, D, E and K)

>> Question: What is the function of DNA?

DNA can store and transmit all the genetic information needed to build organisms. For instance, in human beings the single fertilized egg cell carry the information for making legs, hands, head, liver, heart, kidneys etc. DNA is found primarily in the cell nucleus.

Question: Describe the importance of nucleic acids.

Nucleic acids are vital components of all life. They are found in every living cell. They serve as the information and control centers of the cell.

==

>> Question: Distinguish between mono, di-, and tri-saccharides.

Monosaccharide:

Monosaccharide is simple sugar consists of only one unit. They serve as building blocks for more complex carbohydrate forms. For example Glucose, Fructose, Galactose, Lyxose and Xylose.

Disaccarides:

Disaccarides are group of sugars composed of two monosaccharide groups linked together through the loss of sugar. For example

Maltose = Glucose + Glucose

Sucrose = Glucose + Fructose

Lactose = Glucose + Galactose

Trisaccharides:

Trisaccharides are sugars containing three hexoses. For example Raffinose, found in molasses contain the three hexoses. Nigerotriose Maltotriose Melezitose.

>> Question: What are the sources of lipids?

- Animals, plants, and marine organisms such as salmon and whales are rich source of lipids.
- Milk is an important source of animal fat from which butter, ghee, ground nut, coconut, olive etc are good source of vegetable oils.
- Cod liver oil is obtained from salmon and whales.

Question: Differentiate between fats and oils.

A lipid is called fat if it is solid at room temperature. A lipid is called oil if it is liquid at room temperature. The differences in melting points are due to the degree of unsaturation of constituent fatty acids. Fats contain larger proportion of saturated fatty acid units. Oils contain larger proportion of unsaturated fatty acid units. Both are lipids. The main difference is that oil is liquid at room temperature, and fat is not.

Question: Explain hydrogenation of vegetable oil.

Addition of hydrogen to an alkenes is called hydrogenation. This reaction takes place in the presence of Ni, Pd or Pt as catalyst.

This reaction is used to make margarine or vegetable ghee. Fatty acid component of vegetable oil contains carbon-careen double bonds. When hydrogen is added to these oils, they become saturated and harder.

Question: List commercial uses of enzymes.

Enzymes are large protein molecules. They are biological catalysts. They catalyze chemical reactions in living organisms. Enzymes are also commercially important. They are used in the production of sweeteners, chocolate syrup, bakery products, infant foods, detergents to remove food stains, in cheese making, 'in paper and pulp industries to remove sticky matter, to prepare fabrics for clothes, furniture and other household items.

Question: Life requires energy. Where this energy comes from?

All life require energy, which usually enters organisms as sunlight, is transformed into organic compounds such as sugar, and exits as heat.

Question: Can you use the energy of sun light directly to perform all life activities?
No, we cannot use the energy of sun light directly to perform all life activities.

Question: Plants trap sun energy and convert it into chemical energy. How?
Plants store sun energy in substances such as carbohydrates, proteins and lipids. We need these compounds for existence.

Question: For proper nutrition, our diet should include which type of proportions.
For proper nutrition, our diet should include balanced proportions of carbohydrates, proteins and lipids. We also need adequate amount of vitamins, minerals and fibre.

Question: Some compounds found in every living cell, serve as the information and control centers of the cell. They have ability to reproduce, store and transmit genetic information. What are these compounds?
Deoxyribonucleic acid (DNA).

Question: What is Protein deficiency?
Protein deficiency leads to physical and mental retardation. Excess lipids or fats may lead to heart diseases or a stroke, cancer, diabetes and other health problems. The nutritional chemists recommend that no more than 30 % of your daily caloric intake come from fat.

Question: List the classification of carbohydrates?
Carbohydrates are classified as:
i) Monosaccharide ii) Oligosaccharides iii) Polysacchar des

Question: What is the chemical nature of monosaccharides? Discuss their structure?

- Monosaccharides are the simplest carbohydrates. They cannot be hydrolyzed.
- They have general formula $(CH_2O)_n$ where n is 3 to 6 carbon atoms. So monosaccharides contain 3 to 6 carbon atoms.
- Monosaccharides are further classified as trioses, tetroses, pentoses, hexoses etc. This classification is based on the number of carbon atoms they contain.
- Monosaccharides are white crystalline solid. They are soluble in water and have sweet taste. They cannot be hydrolyzed. They are reducing in nature.

Question: What is the use of dextrose in drips?
5% m/v aqueous solution of dextrose is used in drips. 5% m/v aqueous solution means 5 grams of dextrose dissolved in water to form $100cm^3$ of solution. It is intravenously given to patient who is severely dehydrated or is unable to eat or is not allowed to eat.

Question: Is glucose a pentose?
No, glucose is hexose ($C_6H_{12}O_6$).

Question: What is the chemical nature of oligosaccharides? Discuss their structure?

- Carbohydrates which upon hydrolysis form 2 to 9 molecules of monosaccharides or simple sugars are called oligosaccharides.
- They are further clarified as disaccharides, trisaccharides etc. Prefixes di, tri, tetra, penta etc. indicate the number of monosaccharide units, they produce on hydrolysis. They are white crystalline solids. They have sweet taste and are soluble in water.

Question: What is the chemical nature of polysaccharides? Discuss their structure?

Carbohydrates which upon hydrolysis form 100 to 1000 units of simple sugars are called polysaccharides. Starch and cellulose are polysaccharides. They are amorphous solids. They are tasteless and insoluble in water. They are non-reducing in nature.

Question: What are proteins? Write their function.

Proteins are complex nitrogenous substances that produce amino acids on complete hydrolysis.

Functions of proteins:

i) Proteins transport and store oxygen and nutrients.
ii) Proteins act as catalysts for the thousands of reactions that make life possible.
iii) Proteins regulate many important systems in our bodies.

Characteristics of proteins:

Proteins are high molecular weight polymers. The building blocks of all proteins are the amino acids therefore; all proteins produce amino acids on hydrolysis.

Question: An amino acid has two functional groups. What are those?

An amino acid has two functional groups. Alt amino acids have a carboxyl and amino group in order for them to form long continuous chains of proteins.

Question: What is Kwashiorkor:

An extreme lack of proteins and vitamins causes a deficiency disease called kwashiorkor. The symptoms include retarded growth, discolouration of skin and hair, bloating, a swollen belly and mental apathy.

Question: What is Loss of vitamins:

Some foods lose their vitamin contents when they are cooked in water and then drained. The water soluble vitamins go down the drain with water. For example rice, pulses, beans, gram, peas etc.

Question: What is Lipid?

A lipid is any component of plant or animal tissue that is insoluble in water, but soluble in solvents of low polarity such as ether, hexane, benzene and carbon tetrachlonde.

Question: What is Fatty acid?
Fatty acids are long chain carboxylic acids. A lipid is called fat if it is solid at room temperature. A lipid is called oil if it is liquid at room temperature.

Question: What are Source of lipids:
Animals, plants and marine organisms such as salmon and whales are rich source of lipids

Question: What is Nucleic acids?
Nucleic acids serve as the information and control centers of the cell.

Question: What is DNA?
DNA exists in the form of two strands twisted around each other in a spiral formation called a double helix.

LONG QUESTION

>> Question: Describe bonding in a protein molecule?
An amino acid has two functional groups. All amino acids have a carboxyl and amino group in order for them to form long continuous chains of proteins. Amino acids are building blocks of protein synthesis. Twenty different amino acids are involved in protein synthesis.

Non-Essential and Essential amino acids:
Out of 20 amino acids, our bodies can synthesize only 10 such amino acids. Such amino acids are called non-essential amino acids. The remaining 10 are essential amino acids.

Joining of two molecules of amino acids:
Molecules of amino acids join together through amino ($-NH_2$) group of one molecule and carboxyl ($-COOH$) group of another molecule by eliminating a molecule of water.

Peptide Bond:

$$-\overset{\overset{\displaystyle O}{\|}}{C}-NH-$$

The linkage – C – NH – which joins two amino acids units is called a peptide bond. The resulting molecule is called dipeptide. There is still an amino group on the left and a carboxyl group on the right. Each of these groups can react further to join more amino acid units. In this way thousands of amino acids units join to form a giant molecule of protein.

>> Question: What are uses of lipids?
- Butter, ghee and vegetable oils are used for cooking and frying of food, preparing bakery products and sweets.
- In mammals a layer of fat is present under the skin. This layer acts as a thermal insulator.
- Fats protect delicate organs from shocks. A layer of fat around our heart and kidneys protect these organs from injury.

- Lipids provide some vitamins such as A, D and E which are essential for health, These vitamins are insoluble in water and soluble in lipids.
- Fats and oils are important food stores in living organisms. They provide about twice, as much energy per gram as do carbohydrates.
- Vegetable oils are converted into vegetable ghee or margarine by catalytic hydrogenation.
- Fats and oils are also used for the manufacture of materials like soaps and detergents, cosmetic, polishes, paints and varnishes
- In our bodies cholesterol is essential for the synthesis of several hormones, vitamin D and bile acids.

>> Question: Give sources and uses of proteins.
Meat, fish, eggs, milk and cheese are important sources of proteins. Plants also provide us proteins. For example, pulses, beans, meat, egg, fish etc. are rich in proteins.

Uses of Proteins:

- We require proteins in our diet, to provide amino acids to make muscles, hair, enzymes and repair of body tissues.
- Proteins are essential for the formation of protoplasm and components of cells.
- Proteins are essential for. both physical and mental growth especially in children.
- A protein called gelatin is obtained by heating bones and tendons in water.
- It is used in bakery goods.
- Enzymes are proteins that catalyze specific biological reactions, without which life would be impossible.
- The antibodies that help us to fight against disease are large protein molecules.

What are Uses of Carbohydrates:

- Carbohydrates store and transport energy in both plants and animals. 1g of glucose provides us 15.6 KJ of energy.
- They serve as food source for most organisms.
- Carbohydrates serve as structural material for plants. Cellulose in the human diet is referred as fibre. It is found in bran, whole meal bread, fruit and vegetables. We cannot digest it but. it is very important for us. It helps the muscles of your intestines to move food efficiently through the digestive track. It absorbs and carries away toxic chemicals In food that would otherwise harm us. It also helps in lowering cholesterol and regulates blood pressure.
- Sucrose in used as common table sugar.
- Glucose is stored in animal muscles and liver cells in the form of glycogen.
- Glycogen serves as long term energy reservoir. It can be converted back to glucose when needed for energy. Plants store excess energy as starch.
- Starch is used to make rectified spirit by fermentation process.
- Starch is converted to dextrin which is used as an adhesive for stamps and as wallpaper glue.

- Cows, cattle, goats, deer, sheep and termites derive nutrition from cellulose.
- We use cellulose in the form of woqd for heat, housing and furniture.
- Wood is also used to make paper and wood pulp.
- Ceflutose fibre of cotton is used to make rayon and cellulose acetate, which are used in textile industry for making cloth.

Question: Define and explain vitamins.

Vitamins are specific organic compounds which are required by our bodies to prevent specific diseases but cannot be produced by our bodies. They must be present in our diet in addition to proteins, fats, carbohydrates and minerals. Vitamin D deficiency causes softening of bones. Vitamin B_3 deficiency causes inflammation and abnormal pigmentation.

Importance of vitamins:

Vitamins are substances that are essential for our bodies.

Vitamin A:

Vitamin A is important in vision. It helps in the chemical transmission of images from the eye to the brain. It also keeps the cornea moist.

Vitamin C:

Vitamin C is required for the formation of blood and boosting the immune system that protects against illnesses ranging from common cold to cancer.

Vitamin B:

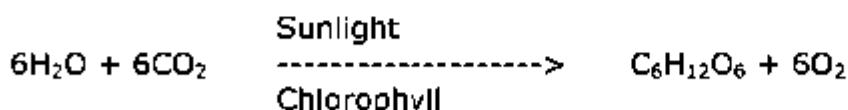
Vitamin B helps to regulate rerve impulse transmissions,- in the formation of haemoglobin and activates more than 100 different enzymes.

Vitamin D:

Vitamin D regulates blood calcium. It is necessary for proper bone and tooth growth.

Question: Explain the sources and uses of carbohydrates?

- Carbohydrates are monomers and polymers of aldehydes and ketones that have numerous hydroxyl groups attached.
- Carbohydrates are the most abundant class of organic compounds. Carbohydrates have the general formula $C_x(H_2O)_y$. This formula suggests that they are hydrates of carbon with few exceptions. Plants synthesize carbohydrates through photosynthesis.

$$6H_2O + 6CO_2 \xrightarrow[\text{Chlorophyll}]{\text{Sunlight}} C_6H_{12}O_6 + 6O_2$$

- Plants convert glucose into starch and cellulose.

=*=*=*=*=

2. Give short answer

i) List two main sources of acid rain.

Ans: Acid rain is caused mainly by the burning of fossil fuels such as coal and gasoline. Oxides of nitrogen and sulphur are released into the air when fossil fuels are burnt and when they mix with the precipitation in clouds acid rain is formed.

ii) List four human activities which contribute to air pollution.

Ans:
- **i.** Burning fossil fuel
- **ii.** Cutting trees
- **iii.** Use of Freon gas
- **iv.** Production of methane from dead plant material decay.

iii) What is the importance of stratospheric ozone?

Ans: Importance of stratospheric ozone:

Ozone saves us from harmful effects of incoming ultraviolet radiations from the sun. When ozone absorbs energy from the sun, the energy is converted into heat, warming the air. The ozone layer protects the living things on the Earth from dangerous ultraviolet radiation from the sun.

iv) What is the role of automobile in air pollution

Ans: Exhaust fumes of automobiles including dangerous gases such as carbon monoxide, oxides of nitrogen, hydrocarbons and particulates. These exhaust fumes of automobile are responsible for air pollution.

v) Define atmosphere.

Ans: Atmosphere:

The envelope of gases and water vapour surrounding the planet earth is called atmosphere.

3. Explain temperature variation in stratosphere and troposphere.

Ans: Temperature variation in stratosphere:

In the stratosphere, temperature varies from -55°C to -5°C

Temperature variation in troposphere:

As altitude increases in the troposphere, the temperature decreases from 17°C to about -55°C. On average, for every 1 km increase in altitude, the air gets about 6.5°C cooler.

4. List components of stratosphere and troposphere.

Ans: Component of stratosphere:

This layer contains little water vapours. Interesting information about this layer is that it contains maximum amount of ozone (about 10ppm/parts per million) The presence of ozone is responsible for the rise in temperature in stratosphere.

Components of troposphere:

Nearly all the dust particles and water vapours are in the troposphere. Weather occurs in this layer. Most of the clouds are formed in the troposphere Aircrafts fly in this region.

5. Describe sources of air pollutants.

Ans: Sources of Air Pollution:

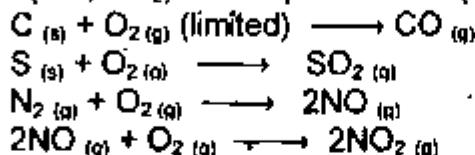
Air that contains harmful particles and gases is said to be polluted. Some air pollution occurs naturally. But many types of air pollution are the result of human activities.

i. Natural Sources:

Many natural processes such as forest fires and dust storms release smoke and dust particles into the air. Volcanoes emit clouds of dust and poisonous gases along with ash. Termites and cows also release large amount of methane in the air. Considerable electrical discharges in the atmosphere produce nitrogen oxides.

ii. Human Activities:

Most of the air pollution is the result of burning fossil fuels, such as coal, petroleum and natural gas. Nearly half of the air pollution comes from cars and other motor vehicles. Factories and power plants that burn coal or oil release poisonous gases in the air. Burning fossil fuels and incineration release carbon monoxide (CO), nitrogen oxides (NO, NO_2) and sulphur oxides (SO_2, SO_3).

$$C_{(s)} + O_{2(g)} \text{ (limited)} \longrightarrow CO_{(g)}$$
$$S_{(s)} + O_{2(g)} \longrightarrow SO_{2(g)}$$
$$N_{2(g)} + O_{2(g)} \longrightarrow 2NO_{(g)}$$
$$2NO_{(g)} + O_{2(g)} \longrightarrow 2NO_{2(g)}$$

Chlorofluorocarbons:

Chlorofluorocarbons have been widely used as solvents for cleaning electronic circuit boards, as refrigerant in fridges and air-conditioning units and as propellants in aerosol sprays (air fresheners, hairsprays, deodorants, spray paints). Such products are not "Environment friendly". During manufacture, in use and after disposal, these compounds escape into the air.

Lead particles:

Lead particles in the air come mainly due to the combustion of leaded petrol or fuel used in motor vehicles or from lead based paints.

Ozone:

Ozone is produced when electrical discharges pass through oxygen in the air. You can feel its presence near photocopier, television set, microwave oven and other electrical equipment.

$$3O_{2(g)} \xrightarrow[\text{discharge}]{\text{Electrical}} 2O_{3(g)}$$

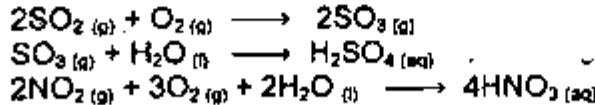
6. Describe acid rain and its effects.

Ans: Acid Rain and Its Effects:

Acid rain is defined as rain having pH less than 5.6.

Normal rain water is saturated with carbon dioxide. It has pH of 5.6 However; the acidity of rain greatly increases in polluted areas during thunderstorm.

Sulphur dioxide from power plants using fossil fuels and nitrogen oxides from exhaust fumes of automobiles dissolve in rain water producing acids.

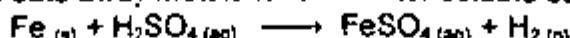
$$2SO_{2(g)} + O_{2(g)} \longrightarrow 2SO_{3(g)}$$
$$SO_{3(g)} + H_2O_{(l)} \longrightarrow H_2SO_{4(aq)}$$
$$2NO_{2(g)} + 3O_{2(g)} + 2H_2O_{(l)} \longrightarrow 4HNO_{3(aq)}$$

Therefore, during thunderstorm, the pH of rain water can be much lower because of sulphuric acid and nitric acids formed by lightening. This rain may have pH as low as 2.1. This value is lower than the pH of vinegar or lemon juice.

Effect of acid rain:

Acid rain may often fall hundreds of kilometer away from their sources. Acid rain corrodes metals, stone buildings and statues. Marble statues are slowly eroded by acid rain.

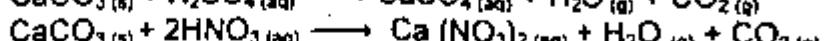
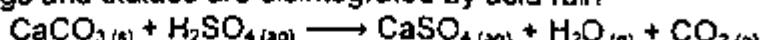
Sulphuric acid and metals:

Sulphuric acid eats away metals to form water soluble salts and hydrogen

$$Fe_{(s)} + H_2SO_{4(aq)} \longrightarrow FeSO_{4(aq)} + H_{2(g)}$$

Marble buildings and statues:

Marble buildings and statues are disintegrated by acid rain

$$CaCO_{3(s)} + H_2SO_{4(aq)} \longrightarrow CaSO_{4(aq)} + H_2O_{(g)} + CO_{2(g)}$$

$$CaCO_{3(s)} + 2HNO_{3(aq)} \longrightarrow Ca(NO_3)_{2(aq)} + H_2O_{(g)} + CO_{2(g)}$$

Acid rain also kills fish, and destroys trees. Lakes and river may become too acidic for living things to survive. Trees destroyed by acid rain. Fish are killed by acid rain.

7. Describe ozone depletion and its effects.

Ans: Ozone Depletion and Its Effects:

Human activity releases many compounds in the atmosphere. Such compounds threaten the stability of ozone layer. Over recent years, scientists have discovered a reduction in the amount of ozone in the stratosphere.

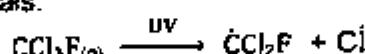
Ozone hole:

The region in which the amount of ozone has been reduced is called as ozone hole. Ozone hole was first observed in October, 1980 over Antarctica.

Chlorofluorocarbons:

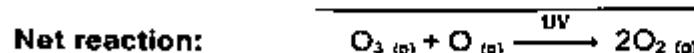
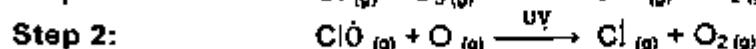
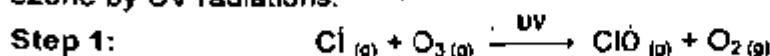
Chlorofluorocarbons (from aerosol cans, air conditioning systems, refrigerators etc) escape into the atmosphere. CFCs are gases or low boiling liquids.

They are so inert that they do not react with any other chemicals in the troposphere. They slowly diffuse into the ozone layer. UV radiation break CFCs molecule producing chlorine free radicals.

$$CCl_3F_{(g)} \xrightarrow{UV} \dot{C}Cl_2F + \dot{Cl}$$

Chlorine free radical reacts with ozone to form chlorine monoxide (ClO) and molecular oxygen. ClO reacts with atomic oxygen produced by the decomposition of ozone by UV radiations.

Step 1: $\dot{Cl}_{(g)} + O_{3(g)} \xrightarrow{UV} Cl\dot{O}_{(g)} + O_{2(g)}$

Step 2: $Cl\dot{O}_{(g)} + O_{(g)} \xrightarrow{UV} \dot{Cl}_{(g)} + O_{2(g)}$

Net reaction: $O_{3(g)} + O_{(g)} \xrightarrow{UV} 2O_{2(g)}$

The chlorine free radical that reacts in step 1 is regenerated in step 2. One $\dot{Cl}$ can, therefore, destroy thousands of ozone molecules. Figure 14.10 shows depletion of ozone layer over the years.

Satellite images, the blue area of normal ozone level is getting progressively smaller as time goes

8. Describe global warming.

Ans: Global warming:

The warming of the atmosphere which is due to our influence on the greenhouse effect is known as global warming.

Global warming as a green house effect:

Global warming is due to an upset in the natural balance of the concentration of greenhouse gases in the atmosphere. If global warming continues, then

- Temperature of the earth will gradually increase.
- The earth climate may change, affecting both where there is rainfall and how much there is of it. This could cause both increased risks of flooding in some regions and drought in others.
- Polar ice may melt and cause significant increase in sea levels.
- So the atmosphere becomes hotter.

9. Differentiate between stratosphere and troposphere

Ans: Location:

The troposphere is the layer of the atmosphere that touches Earth. From the surface of the earth, the troposphere extends out 6-8 kilometers from the poles and 17 kilometers from the equator.

Between the troposphere and stratosphere is a small layer of the tmosphere called tropopause. The stratosphere is about 50 kilometers from the surface of the earth.

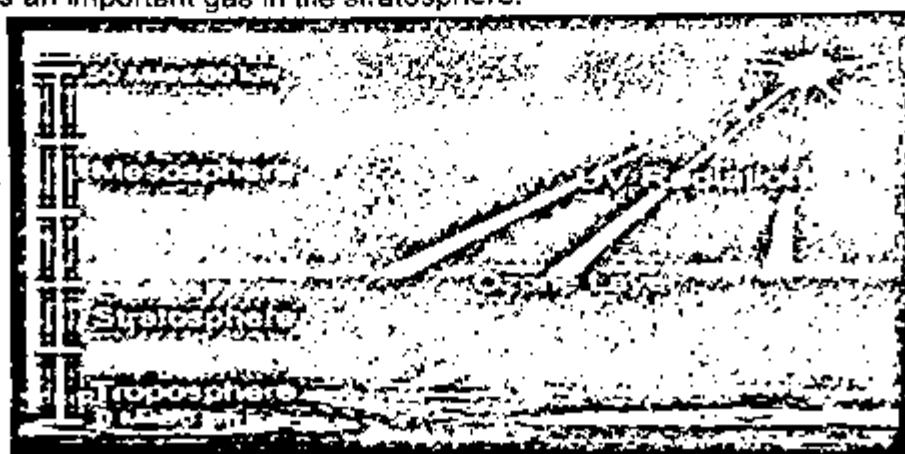
Temperatures:

The temperatures in the troposphere decrease by 6.5 degrees Celsius for every kilometer away from the earth's surface. The temperature stabilizes at around 12 kilometers.

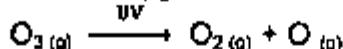
The stratosphere's temperature is about -50 degrees Celsius where it is closest to the earth. The upper layers are actually warmer and average -18 degrees Celsius. The reason for the warming, as this layer gets farther from the earth, is the presence of Ozone. Ozone absorbs sunlight and reflects it away from the earth.

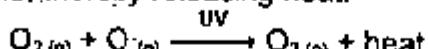
10. Explain ozone formation.

Ans: Formation of ozone:

Ozone is an allotropic form of oxygen comprising there oxygen atoms. O_3 Ozone is an important gas in the stratosphere.

Ozone Layer

Most of the ultraviolet (UV) radiations coming from sun are **filtered** or **screened** out by the ozone layer. Otherwise, sunlight would be much more hazardous for human beings, animals and plants. On absorbing UV radiation, ozone molecule breaks up to form a oxygen molecule and atomic oxygen.

$$O_{3(g)} \xrightarrow{UV} O_{2(g)} + O_{(g)}$$

Atomic oxygen is very reactive. Atomic oxygen reacts readily with an oxygen molecule to form ozone, thereby releasing heat.

$$O_{2(g)} + O_{(g)} \xrightarrow{UV} O_{3(g)} + heat$$

These reactions maintain level of ozone in the stratosphere. Both the destruction and the reformation of ozone are powered by UV radiation. In the absence of outside intervention, the rates of ozone destruction and formation are equal. However, human activities disturb this natural balance.

11. Why is global warming often referred to as the greenhouse effect?

Ans: The **enhanced greenhouse effect** (or accelerated greenhouse effect) is the warming effect caused by all the extra carbon dioxide greenhouse gas that man has put into the atmosphere in the past 100 years by burning fossil fuels (coal, oil and natural gas).

Global warming is the warming of the earth because of this enhanced greenhouse effect.

12. There is scientific evidence that CFCs contribute to the depletion of ozone. Why?

Ans: Ozone hole:

The region in which the amount of ozone has been reduced is called as ozone hole. Ozone hole was first observed in October, 1980 over Antarctica.

The CFCs are so stable that only exposure to strong UV radiation breaks them down. When that happens, the CFC molecule releases atomic chlorine. One chlorine atom can destroy over 100,000 ozone molecules.

13. Sulphur dioxide is a common pollutant from burning coal. State two effects caused by this pollutant.

Ans: Sulphur Oxides (SO_x):

In the air sulphur dioxide is converted into sulphur trioxide, which is responsible for acid rain.

Sulphur dioxide is readily absorbed in the respiratory system. Being powerful irritant, it aggravates the symptoms of people who suffer form asthma, bronchitis, emphysema and other hung diseases.

THINK-TANK

14. Dibenzothiophene ($C_{12}H_8S$) is a common sulphur containing compound of coal. It is responsible for acid rain. How?

Ans: Dibenzothiophene ($C_{12}H_8S$) is a sulphur containing compound of coal on burning it produces sulphur dioxide. In the air sulphur dioxide is converted into sulphur trioxide, which is responsible for acid rain.

15. There have been various attempts to remove sulphur from coal before it is burned. Suggest reason.

Ans: Sulphur containing compound of coal on burning produces sulphur dioxide. In the air sulphur dioxide is converted into sulphur trioxide, which is responsible for acid rain. Therefore various attempts to remove sulphur from coal before it is burned have been done.

16. Analyze the option what are some ways to reduce pollution caused by cars?

Ans: Catalytic converter:

A catalytic converter transforms CO into CO_2, NO into N_2 and O_2, and unburned hydrocarbons to CO_2 and H_2O. Metals like platinum, palladium and rhodium are used as catalyst in the converter. Government of Pakistan should direct car manufacturers to install catalytic converters in car exhaust system. Government should make strict laws in this regards.

Similar to scrubbers on power plants, catalytic converters reduce NO_x emissions from cars.

17. Suggest reason for the presence of CO in the car's exhaust fumes.

Ans: Carbon monoxide consists of a single carbon atom and a single oxygen atom linked together (CO), and is the product of incomplete combustion of fuel. Most Carbon monoxide is produced when air-to-fuel ratios are too low in the engine during vehicle starting or when the vehicle is not tuned properly, and at higher altitudes, where thin air reduces the amount of oxygen available for combustion.

18. As a global citizen, how can you play a part to reduce air pollution at a personal level?

Ans:

i. Encourage your family to walk to the neighbourhood market.
ii. As far as possible use public forms of transport.
iii. Reduce the use of aerosols in the household.
iv. Look after the trees in your neighbourhood.
v. If possible share your room with others when the airconditioner, cooler or fan is on.
vi. Do not burn leaves in your garden, put them in a compost pit.
vii. Cars should, as far as possible, be fitted with catalytic converters.
viii. Use only unleaded petrol.

SHORT QUESTION

Question: List the impurities present in rain water.
Rainwater contains pollutants, soil, plant parts, insect parts, bacteria, algae, and sometimes radioactive materials that the rain/snow has washed out of the air.

Question: List toxic substances pr sent in household wastes.
Household wastes include, human wastes, livestock wastes, soaps and detergents, paints and oil, food and vegetable wastes, garbage etc.

Question: In what ways, industrial wastes pollute water.
Manufacturing of industrial products are always accompanied by some by-products and waste effluents. These wastes may contain highly toxic compounds and heavy metals such as Pd; Cd, Cr. Hg, As, Sb etc. Water from leather tanr1eries contains large quantities of chromium (VI) salts. Chromium (VI) ions are highly toxic and known to cause cancer.

Question: What is water pollution?
Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater). Water pollution occurs when pollutants are discharged directly or indirectly into water bodies without adequate treatment to remove harmful compounds.

Question: List some waterborne diseases.

i. Cholera
ii. Dysentery
iii. Jaundice
iv. Typhoid
v. Hepatitis

Question: What are pathogenic microorganisms?
An organism of microscopic size, usually a bacteria or virus, that causes disease.

Question: What is hard water? Why is it sometimes undesirable?
Water that gives little lather or forms scum with soap is called hard water.
Hard water is undesirable:

- Hard water with a lot of dissolved minerals usually calcium, does not work with soaps or detergents.
- It is hard to "lather" with hard water, and you use more cleaning product to get the same effect.
- Second, the minerals can be deposited in pipes, fixtures and appliances, clogging or wearing them prematurely.

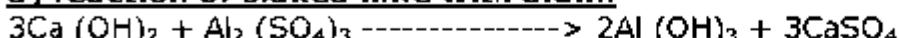
Question: What are the Earth's four main water sources?
The four main sources of water are, ground water, rivers or lakes, oceans and ice (glaciers).

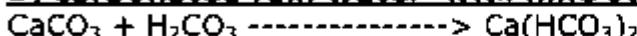
Question: List two ways in which lakes and streams become polluted.

- Industrial units generally discharge their wastes either to open land or into water bodies, lakes, ponds, rivers or oceans.
- Water from leather tanneries contains large quantities of chromium (VI) salts. Chromium (VI) ions are highly toxic and known to cause cancer.
- Industrial wastes cause irreversible degeneration of the environment causing serious health problems for public and marine life.

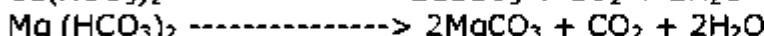
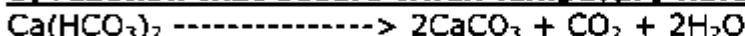
Question: Give chemical equations for the

a) reaction of slaked lime with alum.

$3Ca(OH)_2 + Al_2(SO_4)_3 \longrightarrow 2Al(OH)_3 + 3CaSO_4$

b) carbonated rain water with lime stone.

$CaCO_3 + H_2CO_3 \longrightarrow Ca(HCO_3)_2$

c) reaction that occurs when temporary hard water is boiled.

$Ca(HCO_3)_2 \longrightarrow 2CaCO_3 + CO_2 + 2H_2O$

$Mg(HCO_3)_2 \longrightarrow 2MgCO_3 + CO_2 + 2H_2O$

d) Ca^{+2} ions interact with sodium zeolite

$Ca^{+2} + Na_2Z \longrightarrow 2Na^+ + CaZ$

Question: How can buildings made of limestone be affected by acid rain?

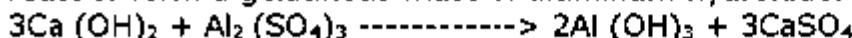
- Acid rain has a corrosive effect on limestone or marble buildings or sculptures. It is well established that either wet or dry deposition of sulfur dioxide significantly increases the rate of corrosion on limestone, sandstone, and marble.
- Sulfur dioxide plus water makes sulfurous acid. Therefore buildings made of limestone are affected by acid rain.

Question: List some disadvantages of water hardness.

- Hard water wastes a lot of soap, when used for washing.
- The soap forms scum with hard water, which adhere to the clothes being washed. Scum can spoil the finish of some fabrics.
- Cause kettles to fur.
- Can cause hot water pipes, boilers and car radiators to block due to the formation of insoluble calcium and magnesium salts, causing great damage.

Question: What is the purpose of coagulation in water treatment?

It is the process in which water is treated with slaked lime and alum. These materials react to form a gelatinous mass of aluminum hydroxide.

$3Ca(OH)_2 + Al_2(SO_4)_3 \longrightarrow 2Al(OH)_3 + 3CaSO_4$

The aluminum hydroxide carries down dirt particles and bacteria.

Question: Explain how hard water hampers the cleansing action of soap.

- Unfortunately, hardness minerals (calcium or magnesium ions) combine with soap to form an insoluble "curd... which can remain as a residue on washed laundry.

- This is similar to the difficult-to-clean residue found or bathroom tubs, sinks, and tile in hard water areas.
- Hardness also tends to counteract soap's alkalinity, which reduces its cleaning ability and requires the use of greater quantities to get laundry clean.

Question: Why is it cooler near a lake than inland during summer?
Since rate of evaporation increases with the increase in temperature during summer. Since evaporation cause cooling therefore it is cooler near a lake than inland during summer.
(Rate of evaporation α temperature)

Question: How chemistry helps maintain a dean swimming pool?
Water in swimming pools is purified from pathogenic organisms by aeration and chlorination. Chlorination is a probably the best and the cheapest method of sterilization of water and it is the most effective in destroying pathogenic bacteria. For chlorination, liquid chlorine may be added directly in the swimming pool water.

Question: Why it is advisable to wash hands well with soap after using bathrooms?
If your hands are not clean and you touch your face or public surfaces, you may be infecting yourself and others by spreading germs and disease. Colds, flus, and infectious diarrhea are all known to be spread by hand-to-hand contact Washing your hands regularly can help keep you 8nd those around you healthy by controlling the spread of germs (bacteria and viruses).

Question: Describe the properties of water.
- Water exists in three different states on Earth. Solid, Liquid, Gas.
- Pure water is transparent, colourless, odourless and tasteless.
- It boils at 100°C and freezes at 0°C at the sea level.
- Water has a high heat capacity.
- Water has a high heat of vaporization.

Question: Water is remarkably versatile solvent. Justify the statement.
The ability of water to dissolve a wide variety of substances is due to its two properties, the polarity of water molecules and the ability of water molecules to form hydrogen bonds. Water molecules are strongly attracted to ions, polar molecules with which water can form hydrogen bonds.

Question: What is Scum?
It is difficult to make the soap lather in hard water. Instead, the water becomes cloudy. This cloudiness is due to the formation of a white precipitate by the reaction of Ca^{+2} or Mg^{+2} ions present in hard water and soap. This white precipitate is known as scum.

Question: How does hard water differ from soft water?

Soft water:

Water that easily gives lather with soap and does not form scum is called soft water.

Hardwater:

Water that gives little lather or forms scum with soap is called hard water.

Question: How does hardness produced in water?

- Rainwater dissolves carbon dioxide as it falls through the atmosphere.
- Carbon dioxide reacts with water to produce carbonic acid, which is a weak acid.
  $CO_2 + H_2O$ <-----------------------> H_2CO_3
- This carbonated water passes over or through the rocks containing calcium carbonate or magnesium carbonate, the acid present in it attacks these rocks.
- It slowly dissolves them, forming calcium and magnesium hydrogen carbonates.
  $CaCO_3 + H_2CO_3$ -------------------> $Ca(HCO_3)_2$
  $MgCO_3$ + H2CO3 -------------------> $Mg(HCO_3)_2$

Question: Which water is soft, tap water or distilled water?

Tap water contains impurities ($CaSO_4$, $MgSO_4$) in the water that distilled water does not have. Therefore distilled water is a soft water.

Question: Have you ever noticed that the pan which is regularly used for boiling water gets white or yellowish deposits at its bottom and sides?

This is due to the boiler scales of $CaCO_3$ and $MgCO_3$.

Question: Differentiate among temporary and permanent hard water. OR Describe the types of hardness of water?

Hardness in water can be divided into two types, temporary and permanent.

Temporary hardness:

Temporary hardness is so called because it can be removed by boiling.

Permanent hardness:

Permanent hardness is so called because it cannot be removed by boiling. Temporary hardness is caused by the presence of dissolved calcium or magnesium hydrogen carbonates. Whereas permanent hardness in caused by the presence of dissolved sulphates and chlorides of calcium or magnesium. Hard water hampers cleaning action of soap.

Question: How to overcome the problem of scum produced by hard water?

To overcome the problem of scum formation in hard water, detergents have been produced. Detergents do not produce a scum. This is because they do not react with calcium or magnesium ions present in hard water. Also detergent molecules are biodegradable. Bacteria can easily break these molecules, so they do not persists in the environment.

Question: Write names of six household wastes.

Household wastes include, human wastes, livestock wastes, soaps and detergents, paints and oil, food and vegetable wastes, garbage etc.

LONG QUESTION

Question: Describe the occurrence of water?

- Water is one of the most important substances on Earth.
- It has been estimated that total amount of water present on earth is about 1.33 billion cubic kilometers which nearly covers 71% of the Earth's crust.
- Fresh water available to man is only 0.2% of the total.
- Sodium chloride is the most abundant salt in sea water. It is present up to 3.4% in it. This water is unfit for human use.

Question: Explain the composition of water? OR How can you split water?

- Water is normally a poor conductor of electricity. However, when electricity is passed through acidified water in a voltammeter, water decomposes.
- It gives hydrogen and oxygen. The process is called electrolysis and the reaction can be written as
  $2H_2O$ -------------------> $2H_2 + O_2$
- The splitting of water molecules produces double amount of hydrogen as compared to oxygen.
- This means hydrogen and oxygen in water are in the ratio of 2:1 by volume.
- Hydrogen is collected at cathode and oxygen is collected at anode.

Question: Highlight the importance of water in the environment including industry.

- You can live without food for 3 to 4 weeks, but cannot survive without water for more than 3 or 4 days.
- Water is crucial for sustaining the reactions that keep us alive. For instance digestion, distribution of food through blood, removal of waste matter from the body.
- It cools automobile engines, nuclear power plants, steel mills and parts of heavy machinery in industrial units.
- It provides means of transportation on the earth surface.
- Farmers need a large amount of water for -their fields for growing fruits, vegetables and crops.
- We need water for drinking, cooking and cleaning.
- It is also used to generate electricity.

Question: What do you understand by water pollution? Describe the causes of water pollution?

- The fresh water we drink or use for our daily life processes is a dilute solution containing a number of minerals.
- When these minerals are in sufficient concentration, water becomes unfit for human use.

- Many human activities also result in the contamination of the surface and ground water. Several forms of pollutants affect water bodies.
- The human activities such as house hold wastes, agricultural wastes, livestock wastes, pesticides, oil leaks, detergents, septic tanks, petroleum; natural gas production may result in contamination of water bodies.

Question: Describe the methods to remove temporary hardness?

i) By Boiling:

Hardness of water can be removed simply by boiling. During boiling the soluble calcium and magnesium hydrogen carbonates are decomposed forming insoluble carbonates. Since Ca^{+2} and Mg^{+2} ions are removed as insoluble carbonates, water becomes soft.

$M(HCO_3)_2 \longrightarrow MCO_3 + CO_2 + H_2O$

Where M = Ca^{+2} or Mg^{+2}

ii) By adding slaked lime (Clark's method):

Temporary hardness in water on the large scale can be removed by adding an estimated amount of slaked lime in it. The slaked lime reacts with the hydrogen carbonates to form insoluble carbonates.

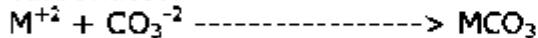
$Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow 2CaCO_3 + 2H_2O$

$Mg(HCO_3)_2 + Ca(OH)_2 \longrightarrow CaCO_3 + MgCO_3 + 2H_2O$

Question: Describe the methods to remove permanent hardness?

i) By adding washing soda:

On the large scale permanent hardness in water can be removed by adding washing soda ($Na_2CO_3.10H_2O$). Ca^{+2} and Mg^{+2} ions are removed as their insoluble carbonates.

$M^{+2} + CO_3^{-2} \longrightarrow MCO_3$

Where M = Ca^{+2} , Mg^{+2}

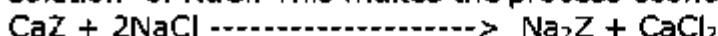
ii) By ion Exchange Resins:

The hard water is passed through a container filled with a suitable resin containing sodium ions. Zeolite is one of the natural ion exchanger. Chemically it is sodium aluminum silicate. It is usually written as Na_2Z. The Ca^{+2} or Mg^{+2} ions causing the hardness are exchanged with Na+ ions in the resin.

$M^{+2} + Na_2Z \longrightarrow 2Na^+ + MZ$

Where M^{+2} = Ca^{+2} , Mg^{+2}

The used up zeolite can be regenerated by heating with concentrated solution of NaCl. This makes the process economical

$CaZ + 2NaCl \longrightarrow Na_2Z + CaCl_2$

Question: Describe the various types of waterborne diseases.

Unclean water supplies, poor sanitation and poor hygiene kill 2,668,000 people worldwide each year. Water in swimming pools is purified from pathogenic organisms by aeration and chlorination.

Some waterborne diseases are given below.

i. Cholera:

Cholera is an intestinal disease. It is caused by bacteria such as vibrio cholerae, E.coli etc. Which may be present in water contaminated with human wastes. It is characterized by vomiting and purging.

ii. Dysentery:

Dysentery is also an intestinal disease. It is caused by parasite, Entamoeba. This infection is transmitted by faecal contamination of water or food by en-cysted organism. Patients have mild to severe abdominal cramps, diarrhea, chocolate coloured stool with mucous and sometimes with blood.

iii. Jaundice:

This disease proceeds from obstruction of liver. Excess of bile from the liver enters in the blood and causes yellowness of skin and eyes. It leads to loss of appetite, weakness and fatigue

iv. Hepatitis:

Hepatitis is acute inflammation of liver. It is caused by viruses, and classified as Hepatitis A, B, C, D and E. Hepatitis A and E spreads through polluted water.

v. Typhoid:

Typhoid is a dangerous intestinal disease. It spreads by polluted water containing bacteria such as salmonella typhi, salmonella paratyphi, anc salmonella enteritidis. It is characterized by continuous fever between 101°F to 104°F and irregular pulse.

Question: How raw water is treated.

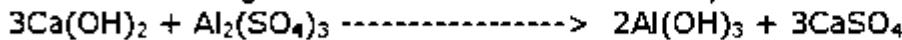
The raw water is treated in a municipal water purification plant, to make it fit for drinking and domestic purposes. Various stages in this treatment are;

1. Sedimentation:

It is the process in which water is allowed to stand in a reservoir.. The suspended matter sinks to the bottom.

2. Coagulation:

It is the process in which water is treated with slaked lime and alum. These materials react to form a gelatinous mass of aluminum hydroxide.

$3Ca(OH)_2 + Al_2(SO_4)_3$ -----------------> $2Al(OH)_3 + 3CaSO_4$

The aluminum hydroxide carries down dirt particles and bacteria.

3. Filtration:

The water is then filtered through sand and gravel. Sometimes it is filtered through charcoal to remove coloured and odorous compounds.

4. Chlorination:

In the final step, chlorine is added to kill any remaining bacteria. Chlorine reacs with water to form hypochlorous acid HClO which kills bacteria.

$Cl_2 + H_2O$ ----------------> $HClO + H^+ + Cl^-$

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SHORT QUESTION

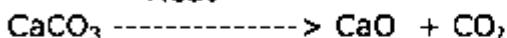
>> Question: How are urea prills produced?

The urea solution is concentrated in vacuum evaporators, which is then rapidly cooled and sent to the prilling tower. Urea prills thus produced are packed and then marketed.

>> Question: What is slaked lime? How is it produced?

Slaked lime is $Ca(OH)_2$

Preparation of slaked lime:

Carbon dioxide is produced by heating limestone in a kiln.

$$CaCO_3 \xrightarrow{\text{Heat}} CaO + CO_2$$

Carbon dioxide is fed into the carbonating tower from the top. Equal amounts of lime (CaO) and water are mixed to produce slaked lime, $Ca(OH)_2$.

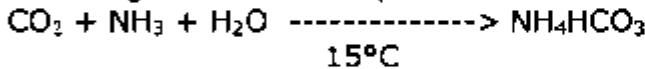
$$CaO + H_2O \longrightarrow Ca(OH)_2$$

>> Question: Write chemical reactions that take place during carbonation in Solvay process.

Carbonation:

In the carbonating tower, carbon dioxide is passed through ammonical brine. Following reaction takes place in it.

$$CO_2 + NH_3 + H_2O \longrightarrow NH_4HCO_3$$

$$NH_4HCO_3 + NaCl \xrightarrow{15°C} NaHCO_3 + NH_4Cl$$

In the lower compartments of carbonating tower, the temperature of the mixture is lowered to 15°C. At this temperature, NaHC03 precipitates out.

>> Question: Explain the process "Roasting" with two examples.

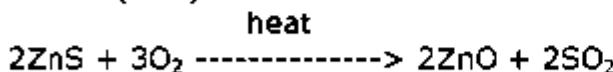
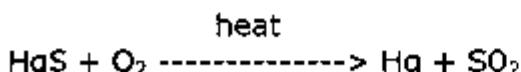
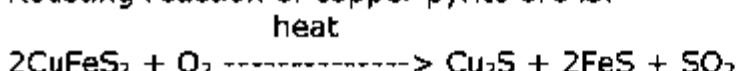
Some minerals are converted to oxide by heating in the air at temperature below their melting point. This process is called roasting. For example, the roasting for zinc blende (ZnS) is

$$2ZnS + 3O_2 \xrightarrow{\text{heat}} 2ZnO + 2SO_2$$

Roasting reaction for cinnabar (HgS) is

$$HgS + O_2 \xrightarrow{\text{heat}} Hg + SO_2$$

Roasting reaction of copper pyrite ore is:

$$2CuFeS_2 + O_2 \xrightarrow{\text{heat}} Cu_2S + 2FeS + SO_2$$

>> Question: Write chemical reactions that take place during urea formation.

Raw materials for the manufacture of urea:

Manufacturing of urea consists of following steps.

i) Ammonia (NH_3)
ii) Carbon dioxide (CO_2)

i) Reaction between NH_3 and CO_2 to form ammonium carbonate.

$NH_3 + CO_2$ --------------> $NH_2CONH_4 + H_2O$

ii) Distillation of ammonium carbonate.

NH_2CONH_4 --------------> $NH_2 - \overset{\overset{\large O}{||}}{C} - NH_2 + H_2O$

iii) Evaporation of liquid urea and its granulation.

The urea solution is concentrated in vacuum evaporators, which is then rapidly cooled and sent to the prilling tower. Urea prills thus produced are packed and then marketed.

>> Question: Make a list of metallurgical operations.

Metallurgy:

The process of separating a metal from its ore and preparing it for use is known as metallurgy.

Basic Metallurgical Operations:

i. Crushing, grinding or pulverizing of the ore
ii. Concentration of the ore
iii. Extraction of metal
iv. Refining of metal.

>> Question: How was crude oil formed?

Origin/formation of Petroleum or crude oil:

- It is believed that petroleum was formed from organisms that lived hundreds of millions of years ago.
- Plants and animals in the seas died. Their remains piled up. Layers of sand, rock and mud buried the dead organisms.
- Over time, in the absence of air, heat and pressure of sediments and bacterial effect changed the material into dark brownish viscous liquid called petroleum. It is also called crude oil.
- The gaseous products accumulated over the petroleum, is called as natural gas.

>> Question: State five specific products made from crude oil.

Natural gas, Butane, Propane, Gasoline, Home heating oil, Plastics, Kerosene and jet fuel, Diesel.

>> Question: Describe composition of urea.

Urea or carbamide is an organic compound with the chemical formula $CO(NH_2)_2$. The molecule has two $-NH_2$ groups joined by a carbonyl (C = O) functional group.

>> Question: Make a list of raw materials for Solvay process.

- Sodium carbonate (Na_2CO_3) or soda ash is an important industrial chemical.
- It is used in the manufacturing of glass, soaps, detergents, paper and many other important chemicals.
- Sodium carbonate is manufactured in a continuous process known as the Solvay process.

Raw Materials:

a) Ammonia
b) Brine (concentrated sodium chloride solution)
c) Lime stone as a source of carbon dioxide and slaked lime, $Ca(OH)_2$

>> Question: Describe the composition of petroleum.

Petroleum is essentially a mixture of hydrocarbons particularly alkanes, cycloalkanes and aromatic hydrocarbons. Apart from hydrocarbons it may also contain compounds containing oxygen and nitrogen.

>> Question: Petroleum is a source of fuels. Name two fuels which are not obtain from petroleum.

There are several types, such as hydrogen fuel (for automotive uses), ethanol, and biodiesel, which are also categorized as a liquid fuel.

>> Question: What has to be done to crude oil before it is useful.

Crude oil is a mixture• of hydrocarbons. These are separated into useful products, such as fuels, using a process called fractional distillation in fractionating tower.

>> Question: Should fossil fuels be burned to provide energy, or should they be used to make useful products like drugs, plastics and chemicals?

Hemp oil or hemp-seed oil is obtained by pressing hemp seeds can be used to create biofuels to replace gasoline for diesel engines. Unlike fossil fuels, biofuels are renewable and produce less of the greenhouse gas carbon monoxide. Therefore fossil fuels should be used to make useful products like drugs, plastics and chemicals.

>> Question: What is the chemical name of dhobi soda or washing soda?

Sodium Carbonate Decahydrate $Na_2CO_3.10H_2O$

>> Question: Define mineral, gangue and ore.

Mineral:

The naturally occurring metallic compounds are called minerals.

Gangue:

The debris, such as sand, rock and clay attached with the mineral is called gangue.

Ore:

An ore is a solid deposit containing a sufficiently high percentage of a mineral to make extraction of metal economically feasible.

>>Question: Explain the process "Concentration" with examples.

Concentration:

After mining ore though crushing, grinding or pulverizing steps is converted into the powder. Then mineral is separated from gangue by some physical method. This process is called concentration. Some of these methods are as Magnetic Separation, Cyclone Separation & Flotation Process etc.

>> Question: Make a list of basic operations In extraction of metals.

After the mineral has been freed of gangue and concentrated it is passed through some chemical process to extract metal.

a) Roasting
b) Smelting
c) Bessemerization
d) Refiding of purification of metals.

>> Question: List the advantages of Solvay process.

i) It is a cheap process. The raw materials are cheap and easily available.
ii) It is a pollution free process. No harmful products are produced.
iii) It consumes less fuel. This is because there is no solution to be evaporated.
iv) Carbon dioxide and ammonia are recovered and re-used in the process.
v) It produces pure $NaHCO_3$ and Na_2CO_3

>> Question: Why fertilizers are added to the soil?

- As the world population has increased the demand for food has increased.
- The world population was 3.5 billion in 1965. By 2050, it will reach 10 billion.
- Many people today are hungry and many more are under-nourished.
- Crops take nutrients from the soil, and these must be replaced before the next crop is sown.
- Fertilizers are the compounds which are put in the soil to provide elements essential for plant's life.
- They are added to the soil to make up the deficiency caused by the previous crops.

>> Question: List the classification of fertilizers?

Fertilizers are classified into two categories:

1. Natural fertilizers:

Natural fertilizers or manures derived from animals and human wastes.

2. Synthetic fertilizers:

Synthetic fertilizers i.e. urea $CO(NH_2)_2$, ammonium sulphate $(NH_4)_2SO_4$, ammonium phosphate $(NH_4)_3PO_4$, calcium super phosphate $Ca(H_2PO_4)_2$ and di-ammonium phosphate $(NH_4)_2HPO_4$.

>> Question: Why urea is one of the widely used fertilizer?

- Percentage of nitrogen is highest among all the synthetic nitrogen fertilizers i.e. 46%.
- It does not affect the texture of the soil.
- In the soil it hydrolyses quickly to ammonium carbonate which eventually changes into NH_3 which decomposes into N_2 and H_2.
- Nitrogen is the main constituent of proteins; it is required by the stems and leaves during the early stages of the plant development.
- It imparts green colour to the leaves and increases the yield and quality of the crop.

>> Question: Compare natural fertilizers with synthetic fertilizers.

Natural fertilizers are better than synthetic fertilizers. Natural fertilizers are insoluble in water. They decompose slowly and gradually by bacteria and liberate useful water soluble nutrients for plants. They do not contain toxic chemicals and hence do not damage the soil crops and plants

>> Question: What do you understand by fossil fuel?

Fossil fuels are energy-rich substances formed from remains of organisms. Coal, petroleum and natural gas are called fossil fuels because they were formed underground from the remains of once-living organisms.

>> Question: Define petroleum.

The name petroleum is derived from Latin words petra (rock) and oleum (oil). It is also called as crude oil. Petroleum or crude oil is thick dark liquid composed mostly of hydrocarbons.

>> Question: Define natural gas.

Natural gas, usually associated with petroleum deposits, cons sts mostly of methane. It also contains significant amounts of ethane, propane and butane.

LONG QUESTION

>> Question: Describe the followings with an example.

a) roasting b) smelting c) flotation

a) Roasting:

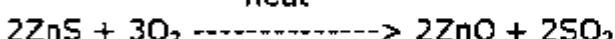
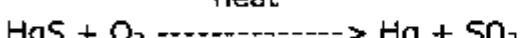
Some minerals are converted to oxide by heating in the air at temperature below their melting point. This process is called roasting. For example, the roasting for zinc blende (ZnS) is

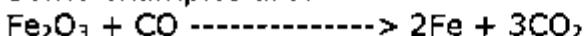
$$2ZnS + 3O_2 \xrightarrow{heat} 2ZnO + 2SO_2$$

Roasting reaction for cinnabar (HgS) is

$$HgS + O_2 \xrightarrow{heat} Hg + SO_2$$

Roasting reaction of copper pyrite ore is:

$$2CuFeS_2 + O_2 \xrightarrow{heat} Cu_2S + 2FeS + SO_2$$

b) Smelting:

- The method to reduce metal ions to free metal is called smelting.
- The most common reducing agents are coke, carbon monoxide and hydrogen.
- Some examples are:
  $Fe_2O_3 + CO \longrightarrow 2Fe + 3CO_2$
  $WO_3 + 3H_2 \longrightarrow W + 3H_2O$
  $ZnO + C \longrightarrow Zn + CO$

However, smelting of copper ore is done in two steps.

i) The roasted copper ore is heated with coke and sand at about 1100°C. The materials melt and separate into two layers. The bottom layer that contains mixture

of Cu_2S and FeS is called matte. While the upper layer is a silicate slag formed by the reaction of FeO and sand

$2FeS + O_2$ --------------> $2FeO + 2SO_2$

$FeO + SiO_2$ --------------> $FeSiO_3$

ii) Bessemerization:

- In this process air is blown through the molten-copper matte in a Bessemer converter.
- Any remaining iron sulplide (FeS) is oxidized and removed as slag ($FeSiO_3$).
- In the final smelting step cuprous sulphide (Cu_2S) is oxidized to form cuprous oxide, which reacts with remaining cuprous sulphide to form metallic copper.

  $2Cu_2S + 3O_2$ --------------> $2Cu_2O + 2SO_2$

  $Cu_2S + 2Cu_2O$ --------------> $6Cu + SO_2$

- The product, called **blister copper** is about 97 to 99% pure Cu, with entrapped bubbles of SO_2. Bessemerization is also used to convert pure iron into steel.

c) Flotation Process:

- Pulverized ore is fed into a tank containing water and an oil-detergent mixture.
- The mixture is agitated with air.
- Detergents wet the mineral particles but not the silicate gangue.
- The mineral particles rise to the top of the mixture as a forth, from where they are skimmed off.
- Particles of the gangue fall down to the bottom.
- The copper ore is concentrated generally by flotation process.

>> Question: Outline basic reactions of Solvay process.

i) Preparation of ammonical brine:

Ammonical brine is prepared by dissolving ammonia gas in brine. Ammonical brine is fed into the carbonating tower.

ii) Carbonation:

In the carbonating tower, carbon dioxide is passed through ammonical brine. Following reaction takes place in it.

$CO_2 + NH_3 + H_2O$ --------------> NH_4HCO_3

15°C

$NH_4HCO_3 + NaCl$ --------------> $NaHCO_3 + NH_4Cl$

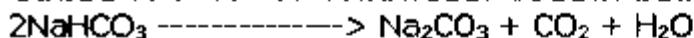
In the lower compartments of carbonating tower, the temperature of the mixture is lowered to 15°C. At this temperature, $NaHCO_3$ precipitates out.

iii) Filtration:

Precipitates of $NaHCO_3$ are separated from the milky solution by filtration. It is used as baking soda.

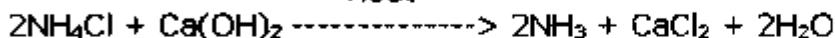
iv) Calcinations:

Sodium hydrogen carbonate is heated to get sodium carbonate

heat

$2NaHCO_3$ -------------> $Na_2CO_3 + CO_2 + H_2O$
Carbon dioxide released is re-cycled in the process.

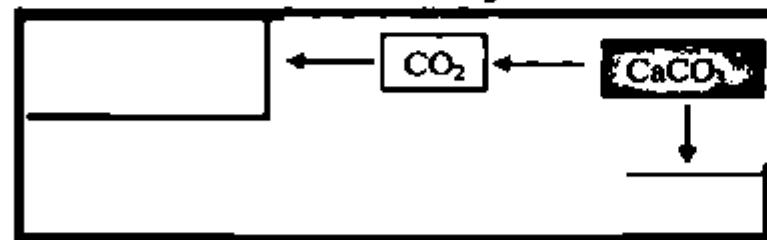
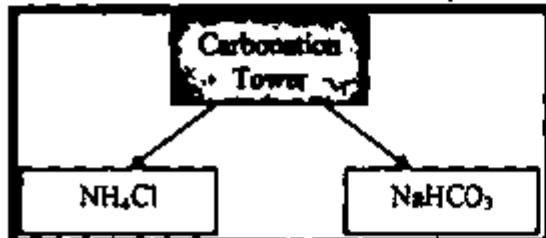
v) Preparation of carbon dioxide and slaked lime.
Carbon dioxide is produced by heating limestone in a kiln.

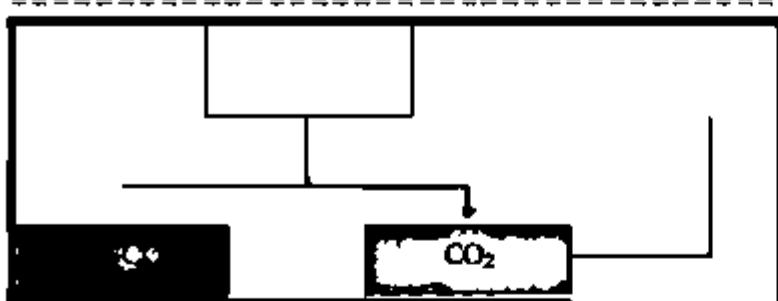
heat
$CaCO_3$ -------------> $CaO + CO_2$
Carbon dioxide is fed into the carbonating tower from the top. Equal amounts of lime (CaO) and water are mixed to produce slaked lime, $Ca(OH)_2$
$CaO + H_2O$ -------------> $Ca(OH)_2$
Slaked lime is pumped to the ammonia recovery tower.

vi) Recovery of ammonia:
Solution congaing ammonium chloride produced in the carbonation tower is heated with slaked lime.

heat
$2NH_4Cl + Ca(OH)_2$ -------------> $2NH_3 + CaCl_2 + 2H_2O$
Almost all the ammonia is recovered in this process. It is reused in the process.

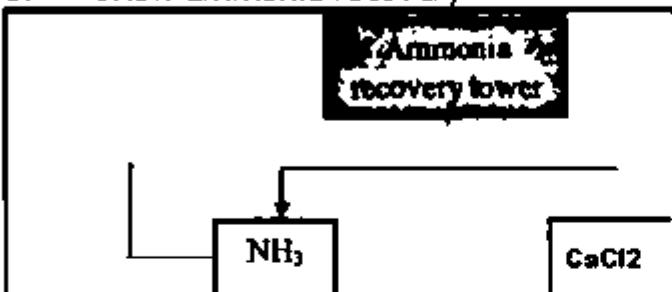
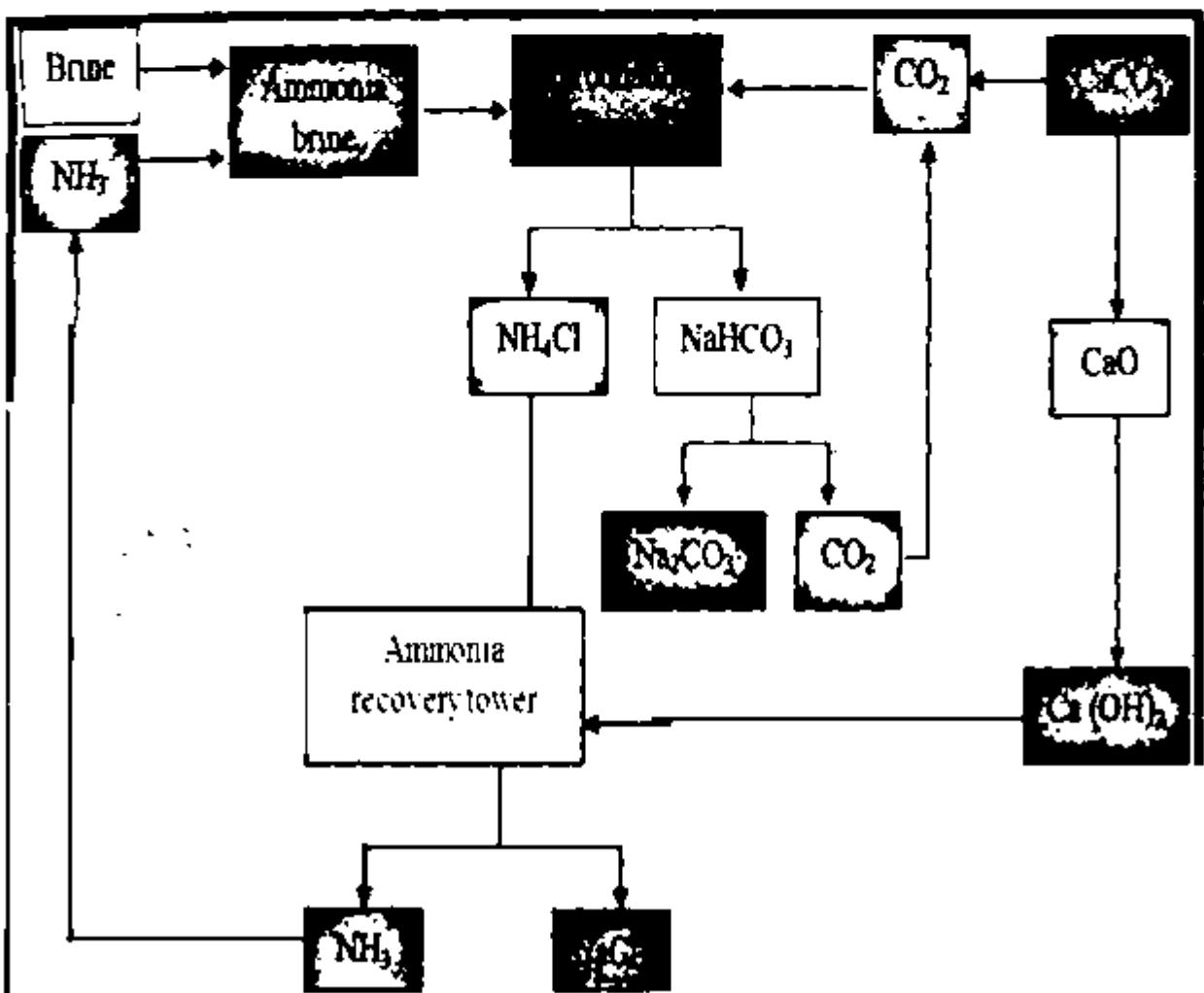
>> Question: Draw flow sheet diagram of Solvay process.

1. Represent each reactant, each product and each reaction chamber or container with one box.
2. Show formation of ammonical brine and join it with carbonation tower

3. Show the formation of CO_2 with a box and connect it with carbonation tower.

4. Show formation of two products from the carbonation tower.

5. Show formation of Na_2CO_3 and CO_2 from $NaHCO_3$ and show recycling of CO_2.

CO_2

6. Show ammonia recovery

Ammonia recovery tower

NH_3 CaCl2

Flow Sheet Diagram (Solvey Proces)

>> Question: Relate the study of chemistry to careers in industry.

- A person who studies chemistry and works with chemicals is called as chemist.
- Chemists have opportunities in all the field of chemistry. For instance, organic chemists have good opportunities to work in industries like petroleum, petrochemical and pharmaceutical.
- They can research on new products, more effective medicines, new pesticides for better crops, new ways to help people reduce environmental pollution etc.
- As a food chemist; you can work in food processing industry.
- You can discover new methods to store, improve texture and flavor of foods.
- In hospitals, chemists analyze blood, urine and stood samples to detect any disease, disease causing bacteria, virus, or other microorganisms.
- As nuclear chemist you can work in the development of new nuclear medicines besides giving chemotherapy and radiation therapy to cancer patients.
- As inorganic chemist you can work in chemical industries such as manufacturing cement, glass, soap and detergent, fertilizer, acids, alkalis, soda ash, dyes, explosives etc.

>> Question: Explain refining or purification of metals?

Refining or purification of metals:

The metal obtained as a result of smelting contains some impurities. So it must be refined. Following methods may be used.

i) Electro-refining:

- An electrolytic cell is used in electro-refining, in which impure metal acts as the anode and a sample of pure metal acts as the cathode.
- For example, electrolytic refining of copper is carried out in an electrolytic tank containing acidified copper sulphate solution as electrolyte.
- Impure slabs of copper act as anode and pure copper sheets as cathode.
- On passing electric current through the solution, impure copper dissolves forming Cu^{+2} ions.
- These Cu^{+2} ions gain electrons at cathode and form Cu atoms, which are deposited on the cathode. In this way pure copper is collected at cathode.
- The impurities like Au and Ag fall off the anode as anode mud.

ii) Distillation:

Metals with relatively low melting points, such as Hg are refined by distillation.

>> Question: Describe briefly the fractional distillation of Petroleum.

- The conversion of crude oil into useful products is called refining.
- These useful products are called fractions. Each fraction consists of a mixture of hydrocarbons which boil in a certain range of temperature.

Fraction distillation:

- Petroleum is refined by fractional distillation in a tall fractionating tower.
- The crude oil is heated up to 400°C under high pressure in a furnace.
- Then it is passed through the fractional distillation column.
- Its vapours rise through the column.

- As hot vapour move up, they condense according to their boiling points into various fractions.
- Compounds with highest boiling points condense first near the bottom.
- Compounds with lowest boiling point condense last near the top.
- Compounds which do not boil, collects at the bottom as residue.
- In this way vapour condense gradually at different levels according to their boiling points.
- Therefore, crude oil is separated into various fractions. Each fraction has its own specific boiling range and composition.

Fraction	**Approx. boiling temperat-ure range in °C.**	**Approx. number of carbon atoms per molecule.**	**Uses**
Petroleum Gases	Below 0	1-4	These gases are liquified and sold as bottled gas for cookers and stoves.
Gasoline (Petrol)	0-65	5-6	Liquids at room temperature used to drive vehicles.
Naphta	65-170	6-10	Naphtha is used by petrochemicals industry as a source of chemicals.
Kerosene Oil	170-250	10-14	Aviation fuel (Jet Fuel) and fuel used in Paraffin stoves
Diesel Oil	250-340	14-19	Used in buses and trains.
Lubricating Oil	340-500	19-35	Used in cars, buses, trucks etc.
Fuel Oil	340-500	Above 20	Used in ships, heating plants and power stations
Bitumen	Above 500	Above 35	Used to tar roads and to water proofs and pipes.

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